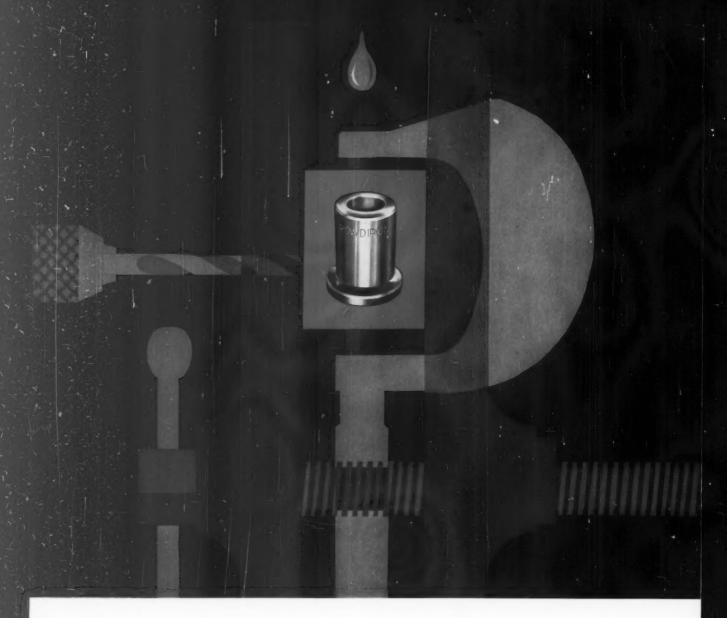
SEPTEMBER 14, 1961

ESIGN

A PENTON PUBLICATION - BIWEEKLY

VHM WEEDES" MICH" 313 Nº EIGSE 21° OMNASESTA WICKONTHS KE' SIEVENS RICE



Which of Powdiron's many talents fit your job?

High strength . . . closest tolerances . . . high oil content . . . excellent machinability. You'll find all these, plus long-wearing durability, economy and more, in the various grades of Powdiron—Bound Brook's bearing material of many talents. Don't choose between quality and economy—get both in Bound Brook Powdiron . . . your best buy in iron bearings.

If your job calls for:	Specify:
High compressive strength good hardness	Powdiron 61-PH
High magnetic permeability	Powdiron S
 Exceptional wear & hardness 	Powdiron T
 Exceptional tensile strength 	Powdiron PCU
Maximum economy	Powdiron 591
 Excellent machinability 	Powdiron FM



BOUND BROOK BEARING CORPORATION OF AMERICA

A BIRFIELD COMPANY

Pioneer in Powder Metallurgy Bearings and Parts • Plants at Bound Brook, N.J. and Sturgis, Mich.

Circle 201 on Page 19



Out of the **Ross** research lab has passed the most extensive line of valves in the air control world

4 fine valves from the Ross valve line



Fast valves manifolded

The PACER 4-way gives 1000 cpm and more, has all JIC features, is built for super long life. Manifold as many as you please. One air supply, one exhaust.



For greater press safety

The Non-Tie-Down valve is designed to protect the press operator's hands. Requires the operator to activate two separate valves continuously during a machine's cycle.



Overriding cam operation

The PCB valve—A ¼" valve with low minimum operating pressure—5 psi to 125 psi—that is fast operating and ruggedly built. Overriding cam activates valve from one direction only.



Air operation with momentary action on a 4-way, 5-port

Need to send a cylinder home hard but return it softly . . . or vice versa? This 4-way, 5-port lets you supply two different pressures to the cylinder. And the air index adaptor gives you momentary action. The main valve reverses and stays put with each air impulse delivered to the air operated head.

For more information write us, or contact your nearby Ross representative. See our digest catalog in Sweet's

THE WORLD'S MOST COMPLETE LINE OF AIR CONTROL VALVES. AVAILABLE ALL OVER THE FREE WORLD.





minute particles of lead...





improve surface finish

On these center aligning balls used in automotive universal joints, CHARLESTON METAL PRODUCTS switched from A.I.S.I. 52100 to the same grade of steel leaded.* They now report improved surface finish . . . a 15% increase in tool life . . , more uniform tolerances in finished parts. They also note that wear and shock resistance are not affected and uniform high hardness (RC 62-63) is maintained. Distortion remains at a minimum.

Results like these are not at all unusual when users switch to free-machining Aristoloy lead-treated steels.

For complete information about Aristoloy electric furnace bars and billets-call your local Copperweld representative or write today.

*Inland Ledloy License



DIVISION OF COPPERWELD STEEL COMPANY

ARISTOLOY STEEL DIVISION (Steel)



4017 Mahoning Ave., Warren, Ohio · EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.



Front Cover: If this issue's cover by orlist George Farnsworth seems a little bit askew, a glance at J. R. Gensheimer's article on Page 154 should straighten out the problem.

Computer in a Shoebox
The Engineer in Industry in the 1960's
Statistical Dimensioning Program
Flexible Couplings
High-Temperature Brazing Alloys
J. RONALD WICKEY—Part 5: Conventional Controls and Their Applications—Descriptions, service classes, operational concepts of general-purpose and definite-purpose controllers.
Stress Relieving of Steel Weldments
File-Wrapper Estoppel
Internally Linked Bellows Joints
Large Plastic Parts
Quadratics-Cubics-Quartics



Gold in Them Thar Hills?

COLIN CARMICHAEL—Editorial

Engineering News

Tempest, Pontiac B Topics 15
Oldsmobile 10 Orbiting Needles 28
Falcon, Continental 12 Ryan's Flex Wing 38
Dart 14 Cryogenic Stretching 40

Trends 22
Picture Report 30
Meetings and Shows 45
Short Courses and Symposia 46

Indicator tells when to clean filter—spring stops liquid, passes gas—position controls size of shim—flexures permit misalignment, provide torsional and axial rigidity—poppet valve regulates and shuts off—pressure controls flow-sensing switch—fulcrum insures uniform braking—vanes measure flow rate—quick-acting closure uses cable-controlled pins—dc stepping motor provides drive and stop in counter—piston controls stroke length in pump—axial movement of worm adjusts worm gear—mirrors permit reading of printing-machine output—residual-magnet core holds relay armature in closed position after actuating current is removed—moving dimple forms contact in commutator.

ditions railroad beds-flip-top boxcars speed handling of clumsy loads.

Drawing large arcs 163 Calculating gear teeth 189

Tips and Techniques

Pencil-lead cushion 189 Solving oblique triangle 192
Design Abstracts 202
New Parts and Materials 250
Engineering Department Equipment 322
Professional Viewpoints
The Engineer's Library
Noteworthy Patents
Backtalk
Helpful Literature
Reader Information Service . 17 Advertising Index

IN THE NEXT ISSUE: The backward art of buying . . . gasket loads in flanged joints . . . plastic piston rings . . . dc motor control . . . pin-joint design . . . control-panel design . . . dowel embossings.

BENJAMIN L. HUMMEL, Executive Editor ROBERT L. STEDFELD, Managing Editor

Senior Associate Editors
LEO F. SPECTOR

LEO F. SPECTOR WILLIAM S. MILLER

Associate Editors

SPENCER R. GRIFFITH JAMES A. PARKS MELVIN E. LONG JESSE W. HUCKERT CLARE E. WISE DONALD R. DREGER

Assistant Editors

THEODORE M. LEACH STANLEY G. COOK RICHARD A. JACOBSON SAMUEL E. BARNES JOSEPH M. HOMITCH FRANCIS J. LAVOIE LEONARD B. STANLEY JAMES C. NOKES JANE H. SMITH MARIAN L. EICHAR

Art Editors

FRANK H. BURGESS ROBERT L. TUFTS

PUBLISHER

ROBERT L. HARTFORD

EDITORIAL OFFICES

Penton Building, Cleveland 13, Ohio

Branch Office:

New York, Detroit, Chicago, Pittsburgh, Washington, London



©1961 by The Penton Publishing Co. All rights reserved.

MACHINE DESIGN is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and mechanical equipment, in U. S. and Canadian companies employing 20 or more people. Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. government installations, performing design engineering of products, are also eligible.

Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, \$10. Single copies \$1.00. Other countries: One year, \$25. When requesting changes of address, etc., please allow four to six weeks for processing.

Published every other Thursday by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.

Anaconda Strip-copper coils cut size and weight

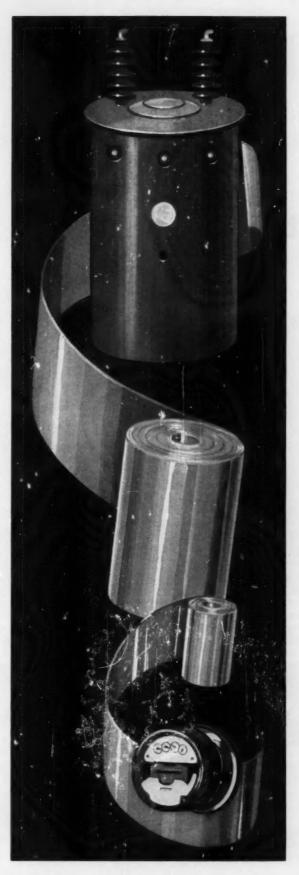
Strip-copper coils cut the size and weight of electrical equipment ranging from watt-hour meters using relatively small coils to pole-mounted distribution transformers rated up to 500 Kva. In many instances operating characteristics can be improved as well.

Anaconda is now supplying high-quality copper strip for such uses. The quality of the copper has been extended to the finish, the edge, the packaging and handling. It is deburred, carefully packaged to prevent edge damage, and made available in a wide range of thicknesses and widths to satisfy all needs.

Whatever your use of coils, whatever size and capacity you wind, Anaconda copper strip promises economies in size and weight.

Technical Assistance in the application of Anaconda strip copper to your coil design problems is available from the Metallurgical Dept. Address: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

ANACONDA AMERICAN BRASS COMPANY

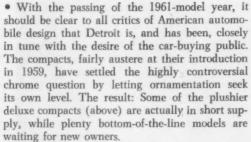


DESIGN

ENGINEERING

the 62 cars

- plushier compacts
- hotter performance
- diminished maintenance



· A Ford vice president has described one of his company's new models as being the most "honestly engineered car" in the company's history. While modesty has never been one of the industry's strong points, the Ford spokesman is very likely right. The car to which he referred has a

light-weight cast-iron engine that pushed foundry techniques far past the state-of-the-art of several years ago. It has two-year radiator coolant, 30,000-mile fuel filter, and needs an oil change only at 6000-mile intervals. Major lubrication is needed at 30,000 miles. Similar engineering feats, in favor of the consumer, are found on most of the '62 models. The "sealed" engine and lube-free chassis are clearly within sight.

• In 1956, the Automobile Manufacturers' Association (AMA) passed a resolution to abolish advertising emphasis on speed and acceleration. These performance characteristics are beginning to creep back into print. One manufacturer boasts of a standard production model that exceeds 130 mph; another is quietly offering a 401-hp en-

gine with four-speed gearbox.





Tempest p. 8



Pontiac p. 8



Oldsmobile p. 10



Continental



Dart p. 14

... Fluid Power NEWS



Report No. 12,301 - From Oilgear Application-Engineering Files

HOW OILGEAR Any-Speed DRIVE SYSTEMS ON SCHMUTZ 6-COLOR PRINTING PRESSES HELP BOOST PERFORMANCE, EFFICIENCY, ECONOMY, CONVENIENCE — IN LESS SPACE

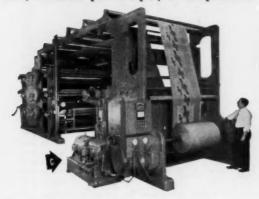
CUSTOMER: Schmutz Manufacturing Company, Louisville, Kentucky.

PROBLEM: Main and rewind drives with control systems for web-fed, 6-color printing presses for printing packaging stock — from 50 or 60-lb kraft, to container and food board. Web widths vary from 40"to 84", with impression "repeat" varying from 14" to 84".

REQUIREMENTS: 1. Constant or absolute tension on the press section to provide "dot-to-dot" register over an infinitely variable (stepless) speed range from 0 to 1000 feet per minute... and hold set speed and tension without variation regardless of fluctuations in load, electrical power input, or temperature.

2. Provide either constant or tapering tension for rewind — from 4" cores to 40" or 60" dia. rolls.

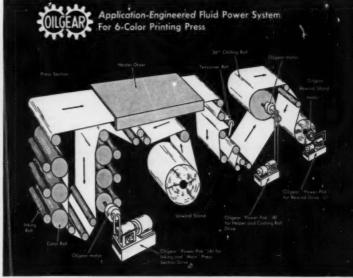
3. Must be economical from the standpoints of installed cost — operation and maintenance — floor space — and electrical power input. 4. Clean, quiet operation — with minimum heat dissipation. 5. To be "packaged" or pre-assembled for simplicity and speed of installation. 6. Eliminate, if possible, the long lineshaft drive that "closed up" one side of the press. 7. Be capable of dependable, trouble-free, continuous, 'round-the-clock operation.



ABOVE: Rewind end of an Oilgear-eq.ipped, 84" Schmutz High Speed Press — with 84" maximum impression repeat, speed range from 0 to 1000 fpm — with constant acceleration and deceleration rates. Oilgear Rewind Drive, indicated, can hold in stalled condition indefinitely — follow press speeds and rewind from a 4" core to 60" roll. The variable, constant or drooping tension characteristics with absolute constant or dacreasing tension — without any steps whatsoever — enable this Oilgear-powered 6-color press to hold register closer than previously experienced.

solution: Three separate Oilgear Servo-Valve-Controlled Pump and Motor Drives to provide stepless, infinitely variable speed control. Fully interlocked feedback systems hold speeds and tensions to a new high degree of accuracy unobtainable with the adjustable speed electrical drives formerly used. An Oilgear "Plus" feature—"memory"—permits the press to be stopped for periods of several hours, and if not reset, will automatically resume operation at the identical former speed and tension. Space requirements are drastically reduced—Oilgear Direct-Drive, Fluid Power Motors are smaller than the gear reducers formerly required—and space consuming power rectifiers are eliminated. Operating economy has been improved—Oilgear Drives use less than ½ the former input power. Oilgear Drives do not require high-speed blowers for cooling—are whisperquiet in operation . . . can hold stall-speed indefinitely without overheating. Another advantage—lower installed cost. These are some of the major advantages that help convince Schmutz to "join the swing" to Oilgear Drives and Control Systems . . . user satisfaction is, of course, the ultimate factor.

For example, one Schmutz customer reports—"Our press is in operation 24 hours per day.—6 days per week. We can measure our Oilgear maintenance in nickels per year . . . with previous drives we had to carry \$1000 worth of tubes in stock."



This is merely one of innumerable "problem drives" solved by Oilgear Application-Engineering teamwork — and Oilgear ANY-SPEED Drives and Control Systems... for new standards of performance — greater accuracy, precision control of speeds, torques, tensions... for new economy of operation, installation, maintenance, and valuable floor space... for longer, more dependable life. These are sound, basic, installation-proved reasons why there are more and more Oilgear users in the paper, printing and converting, marine, food and beverage, chemical, pharmaceutical, primary metals, metal-working, textile, rubber, military, and other industries who all agree that...

"for the lowest-cost-per-year . . . it's OILGEAR!"

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to...

THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

1568 WEST PIERCE STREET . MILWAUKEE 4, WISCONSIN

Phone: Mitchell 5-6715 - Direct Distance Dialing Code - 414

Please direct inquiries to advertiser, mentioning MACHINE DESIGN





Tempest LeMans Convertible

tempest . . .

A CONVERTIBLE—with bucket seats and power top optional—has been added to the Tempest series, formerly offered in four-door sedan, station-wagon, two-door coupe, and sports-coupe models. Styling changes affect the grille, rear end, and interior. The front-engine, rear-transmission arrangement is retained. Improved and/or new are front and rear suspension systems, heater, intake manifold, exhaust system, and camshaft.

pontiac . . .

THE CONVERTIBLE LOOK is achieved by a new roof on Pontiac's hardtop models. The sedan, in turn, is styled to look more like a hardtop. Factory lubrication is good for 35,000 miles, and oil change is needed only every 4000 miles. Carburetors are redesigned for smoother operation and economy, front and rear suspension systems are improved, and redesigned steering arms and tie rods reduce turning diameter by 3 to 3.5 ft.

Engine Options

	Bore & Stroke (in.)	Dis- placement (cu in.)	Com- pression Ratio				e, mas
	4.06 x 3.75	194.5	8.6:1	110 @	3800*	190	@ 2000
(4-cyl)		194.5	10.25:1	140 @	4400°	207	@ 2200
(4-cyl)		194.5	10.25:1	166 @	4800\$	215	@ 2800
(V-8)	3.50×2.80	215	10.25:1	185 @	4800	230	@ 280
	4.06 x 3.75	389	8.6:1	215 @	3600†	390	@ 2000
		389	8.6:1	235 @	3690\$	402	@ 2000
ix		389	10.25:1	303 @	4600\$	425	@ 2800
		389	10.75:1	318 @	46001	430	@ 3200
		389	10.75:1	333 @	4800\$	425	@ 2800
		389	10.75:1	348 @	48001	430	@ 3200
		& Stroke (in.) 4.06 x 3.75 (4-cyl) (4-cyl) (V-8) 3.50 x 2.80 and 4.06 x 3.75	Stroke (in.) placement (cu in.)	& Stroke (in.) Blacement (cu in.) pression Ratio 4.06 x 3.75 194.5 8.6:1 (4-cyl) 194.5 10.25:1 (Y-8) 3.50 x 2.80 215 10.25:1 ad 4.06 x 3.75 389 8.6:1 ix 389 10.25:1 ix 389 10.75:1 389 10.75:1	Stroke (in.) placement (cu in.) Power (bh Ratio Cu in.)	Stroke (in.) Placement (cti in.) Prosition (bhp)	Stroke (in.) Placement (cu in.) Power, max (ib)

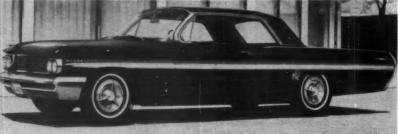
 $^{^{\}circ}=1\text{-barrel}$ carburetion; $\dagger=2\text{-barrel}$ carburetion; $\sharp=4\text{-barrel}$ carburetion; $\sharp=3$ two-barrel carburetion

Body Sizes

Model*	Wheelbase (in.)	Length (in.)	Width (in.)	Height (in.)
Tempest	112.0	189.3	72.2	53.6
Catalina	120.0	211.6	78.6	55.9
Star Chief	123.0	218.6	78.6	55.9
Bonneville	123.0	218.6	78.6	55.9
Grand Prix	120.0	211.6	78.6	54.5

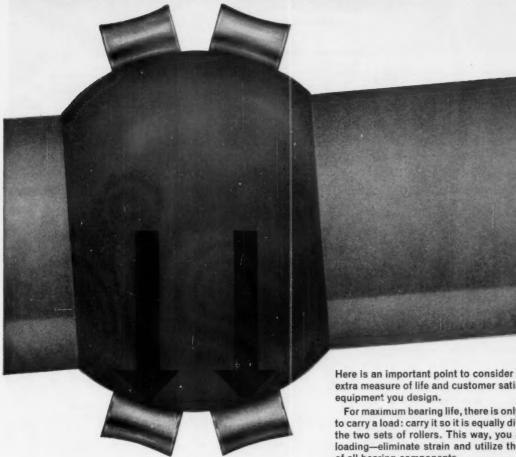
^{*} Dimensions are given for 4-door sedans, except for the Grand Prix which is made only in the 2-door hard-





A lower roof and a back window that doesn't wrap around combine to give Pontiac's two-door hardtop the look of a softtop convertible. Distinctive body styling features include a V-shaped front end and an ample rear end. All 14 models in the 1962 Pontiac line are 1.6 in. longer than last year's.

ELIMINATES MISALIGNMENT STRAIN



maintains

equal load distribution despite changing misalignment Here is an important point to consider if you want an extra measure of life and customer satisfaction in the

For maximum bearing life, there is only one best way to carry a load: carry it so it is equally divided between the two sets of rollers. This way, you avoid unequal loading-eliminate strain and utilize the full capacity of all bearing components.

In the Shafer-Rex design, misalignment is eliminated before it reaches the rollers. So, despite shaft misalignment, the load in a Shafer-Rex is always aligned and equally divided on the rollers-providing extra protection against the strain of any punishment that might be dished out.

Original Shafer-Rex design is the reason. The inner race of a Shafer-Rex Self-Aligning Roller Bearing is a segment of a sphere; rollers are concave. With this design, the only part affected by misalignment is the inner race. Roller assemblies remain in the aligned position, carry the load equally to assure uniform loading through the center of each roller-a real lifesaver.

For information, write: CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.







Series 98 Holiday Sports Sedan

oldsmobile . . .

POWER is up and silhouettes are down across the '62 Olds big-car line. The bhp bonus is real: A recontoured combustion-chamber "roof" and lengthened main bearings allow Olds to boost compression ratios to a premium-fuel 10.25:1 in Rocket and Skyrocket engines (up from 8:75:1 in last year's 88; 10:1 in Super 88 and 98s).

Lower body rooflines are partly a design illusion. "While the new Oldsmobiles appear considerably longer than the 1961 models," says J. F. Wolfram, Olds general manager, "over-all length has actually been increased less than 2 in." Wheelbases are unchanged at 123 in. for the 88s; 126 in. for the 98s.

Engineering advances include replacement of all open-end lube fittings with factory-sealed units, a step which cuts need for periodic lubrication "under normal operating conditions." Self-adjusting power brakes also eliminate periodic brake adjustments. Tapered roller bearings (replacing ball-type wheel bearings) and revised coil-spring rates and shock-absorber valving are principal running-gear modifications.

Scheduled to power a limited-production sports car, this turbo-supercharged, fluid-injection engine will squeeze 1 hp out of each cu in. of displacement (215 cu in. total). According to Olds, the specially formulated "Turbo-Rocket fluid" controls combustion by keeping burning rate uniform. Dotted arrows show flow of the fuel-air mixture, solid arrows show path of injection fluid, and curved arrows show flow of exhaust gas which drives the supercharger.

Engine Options

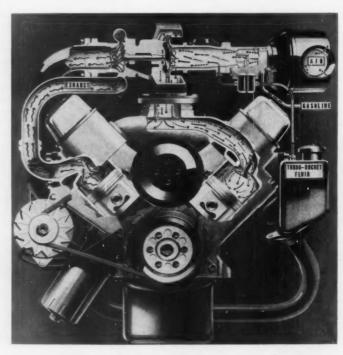
	& Stroke (in.)	Dis- placement (cu in.)	Com- pression Ratio	Power, max (bhp)	Torque, max
Dynamic 88	4.13 x 3.69 4.13 x 3.69	394 394	8.75:1 10.25:1	250 @ 4400° 280 @ 4400°	405 @ 2400 430 @ 2400
Super 88, 98	4.13 x 3.69	394	10.25:1	330 @ 4600†	440 @ 2800

^{• = 2-}barrel carburetion; † = 4-barrel carburetion

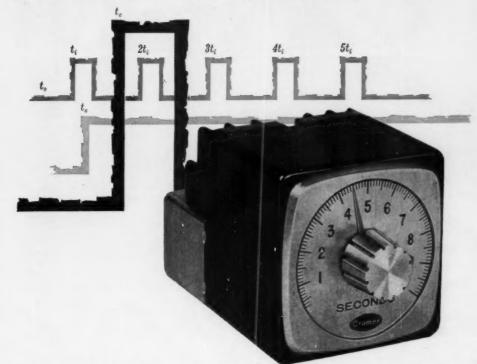
Body Sizes

Model	Wheelbase (in.)	Length (in,)	Width (in.)	Height ⁴ (in.)
88	123.0	213.9	77.9	55.8
Super 88	123.0	213.9	77.9	55.8
98	126.0	220	77.9	56.6

^{* 4-}door sedan



Again — you get the practical answer from Cramer



NEW ELECTRONIC TIMER

MEETS INDUSTRY'S NEED FOR HIGH PERFORMANCE WITH COST SAVINGS YOU'LL APPRECIATE

Here is big news, good news if you must meet tight specs... and do it on a tight budget. This radically new Cramer 940 electronic timer gives you the high performance you want, and gives it to you without needless over-design. Every dollar you pay for this timer contributes to **usable** performance.

Check what you get . . . you'll see advantages offered by no other electronic timer.

SOLID STATE? The Cramer 940 is fully transistorized. No warm-up time, takes bumps and shakes without a whimper.

VERY SHORT INTERVALS? This one has **full-scale** overlapping ranges of 0.1, 1, 10 and 100 seconds.

REALLY ACCURATE? You can control a 0.005 second interval with repeat accuracy of 1 millisecond. And there's no recycling effect

HIGH LOAD CAPACITY? The 940 coolly bosses welders, induction heaters, other heavy-duty equipment.

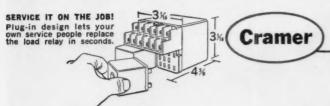
VERSATILE? You have eight external load connections, for SPST or SPDT hook-up of two independent circuits.

REMOTE CONTROL? Push button or toggle switch can be placed at a distance . . . the timing adjustment too, if you wish.

LONG LIFE? Over 40 million cycles for the timing circuit, 10 million for the load relay.

ECONOMICAL? Here's a design with its feet on the ground . . . engineered straight through with a cost-saving efficiency that will surprise you.

Models are available for duty as interval timers, time delay relays, or pulse generating timers. Compact, accurate, endlessly reliable, here is the right timing control for dielectric and induction heaters, molding machines, presses, vulcanizers, welders, X-ray equipment, packaging machines, machine tools, any application where short intervals must be controlled accurately. WRITE for the detailed Technical Bulletin PB-940.



Division • Centerbrook, Connecticut

GIANNINI CONTROLS CORPORATION

INTERVAL TIMERS • CYCLING TIMERS • TIME DELAY RELAYS HERMETICALLY SEALED TIMERS • TIME TOTALIZERS • TIMING MOTORS Sales Engineering Offices — Boston, New York, Chicago, Los Angeles, San Francisco. Sales Representatives in all Major Cities





Continental Sedan

continental . . .

PRACTICALLY UNCHANGED in appearance, the 1962 Lincoln Continental has been subjected to numerous mechanical refinements. The most significant alteration is a new water-heated choke which cuts idle speeds in stop-and-go traffic. Also new is a kink-proof speedometer cable, described as the first major advancement in speedometer cables in years. Lubricated for life, it consists of a wound core which rotates in a low-friction nylon tube. The tube is enclosed in a wire-wound steel shield and vinyl sheathing.

The rigid quality-control program, inaugurated last year by Lincoln, includes a three-hour run-in for the engine, after which it is torn down and inspected before reassembly and installation in the car. Transmissions are similarly run-in for 30 minutes.

falcon . . .

A FACE-LIFT, three new models, and numerous mechanical refinements are incorporated in the 1962 Falcon line-up. Two of the three models introduced—the Station Bus and Club Wagon—are utility vehicles

which can seat eight passengers in three seats. The Wagon is actually a deluxe version of the Bus. Both vehicles have double doors on the right side and in the rear, in addition to conventional driver and front-passenger doors. Both are of unitized construction, with leaf-spring suspension front and rear.

Falcon boasts many of the maintenance-free characteristics of Lincoln, including factory-installed radiator coolant with a 30,000-mile or two year change interval, and a 30,000-mile fuel filter.

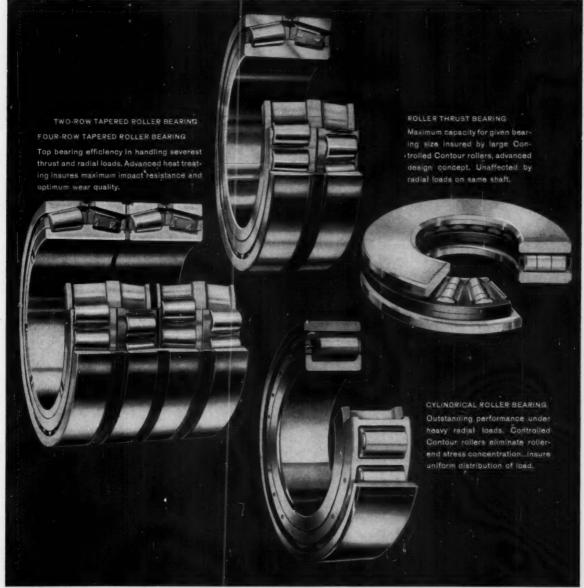
Two-ply tires, introduced on the '62 Falcon, offer several significant improvements over 4-ply versions: They have a 9 per cent larger footprint, for better traction; 12 per cent less rolling resistance, which tends to improve economy; weigh less (by 1 lb per tire), and run cooler.

General Specifications	Continental	Falcon	Falcon Optional
Displacement (cu in.)	430	144	170
Bore & stroke (in.)	4.30 x 3.70	3.50 x 2.50	3.50 x 2.94
Compression ratio	10:1	8.7:1	8.7:1
Power, max (bhp)	300 @ 4100	90 @ 4200	101 @ 4400
Torque, max (lb-ft)	465 @ 2000	138 @ 2000	156 @ 2400
Wheelbase (in.)	123	109.5	
Length (in.)	213	181.1	
Width (in.)	78.6	67	
Height (in.)	53.7	54.5	

Falcon Four-Door Sedan



TORRINGTON



TORRINGTON PRECISION...RIGHT WHERE YOU NEED IT!

Whatever the type of Torrington bearing best suited to your needs, you can be sure of one thing...Torrington precision.

Precision is a byword at Torrington. It represents basic Torrington thinking on every aspect of design, material, engineering and performance.

To you, it means absolute surety in your bearing choice... absolute dependability in every bearing you buy. Remember that Torrington makes every basic type of anti-friction bearing...can advise you impartially on the one that's right for you. If you have a bearing problem, call or write us today.

progress through precision

TORRINGTON BEARINGS

THE TORRINGTON COMPANY

South Bend 21, Indiana, Torrington, Conn.





Series 440 Four-Door Hardtop

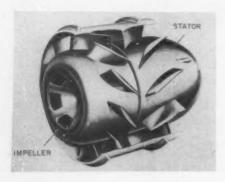
dart . . .

ECONOMY, maneuverability, and ease of handling are emphasized in the new version of the Dodge Dart, first of the Chrysler Corp. cars to go on the market. Lighter (by 200 lb) and shorter than last year's models (116-in. wheelbase, compared to 118), the '62 Dart also features more front-seat head and leg room.

To improve passenger comfort, designers located the engine farther forward and downward in the car. Engines, suspension concepts, and drive-line characteristics are retained from last year, but certain components are considerably changed to accommodate the new wheelbase:

- A small lightweight automatic transmission is offered in the V-8 models.
- Torque converters, converter and transmission housings, steering gear, and the starting motor have all been redesigned smaller.

Darts with six-cylinder engines and automatic transmissions will have rear axles with a 2.93 axle ratio. Former ratio was 3.31. While the new axle does not impair accelerating ability, it does improve fuel economy. The axle ratio for V-8 Darts with automatic transmissions was reduced from 2.93 to 2.76, improving fuel economy in these models too.



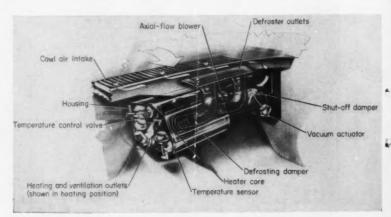
Engine Options

	Bore & Stroke (in.)	Dis- placement (cu in.)	Com- pression Ratio	Power, max (bhp)	Torque, max (lb-ft)
Sinnt Six*	3.40 x 4.12	225	8.2:1	145 @ 4000	215 @ 2800
V-8+	3.91 x 3.31	318	9:1	230 @ 4400	340 @ 2400
V-88 (optional)	3.91 x 3.31	318	9:1	260 @ 4400	345 @ 2800
V-8* (optional)	4.12 x 3.38	361	10:1	305 @ 4800	395 @ 3000

 $^{\circ}=1$ -barrel carburetion; $^{\dagger}=2$ -barrel carburetion; $^{\sharp}=4$ -barrel carburetion with special camphaft

Body Sizes

Model	Wheelbase (in.)	Length (in.)	Width (in.)	Height (in.)
Four-door sedan	116.0	202.0	76.5	54.1
Station wagon	116.0	209.9	76.5	53.9



Forced-air ventilation provides hot-weather comfort in the '62 Darts. A new heating and ventilating system designed around a quiet, axial-flow blower (left) delivers up to 250 cfm of ventilating air, even when the car is at a stand still. The blower, first of its type used by the automotive industry, doesn't depend on ram air. It is designed to be continuously operated, ensuring adequate ventilation during slow-moving or stop-go driving. Air enters through a cowl inlet, passes through the right side of the dash into the blower tunnel, and is forced into a housing which contains the heat core and the distribution dampers. From the housing, the air goes through outlets which are automatically positioned for heating, defrosting, and ventilating.

Topics

Inkless ball-point pen writes at a speed of 9000 fpm, producing highcontrast, permanent markings on paper. The markings are made ultrasonically by a writing instrument developed by Ultrasonic Industries Inc., Plainview, L. I., New York. Among the pen's accomplishments are the ability to write under water, positioned at any angle, in temperatures from absolute zero to 500 F, and in bone-dry to 100 per cent humid atmospheres. Applications are expected in strip and chart recording instruments, process control instruments, and checkwriting machines.

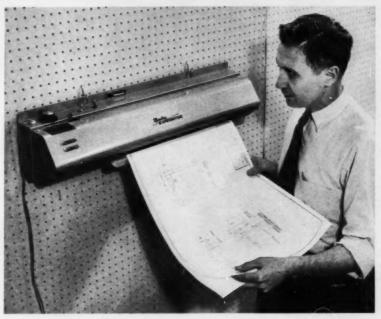
Dapperness after dark is assured by a new electric shaver announced by Sunbeam Corp. It has a built-in light.

One horse develops 10 hp. At the annual meeting of the national breeding society for North-Swedish horses, held in Falun, Sweden, the animals' pulling ability was tested. A timber load was adjusted to correspond to a pulling resistance of 225 kg for mares and 275 kg for stallions. In another test, a car was pulled over a 50-meter track. Peak tractive effort of the mares was 250 kg, and that of the stallions was about 300 kg.

Money changer goes continental to provide travelers at Idlewild International Airport with French, Italian, German or English change for a \$5 bill. The dispenser (which can be stocked with up to six different kinds of monies) accepts the bill, the traveler selects the kind of money he wants and pushes a button, and his money comes out in a small box. Amount is determined by current rate of exchange, and the machine charges 30 cents for its services. National Rejectors Inc., subsidiary of Universal Match Co., makes the changer.

Fitness at fifty fathoms can be maintained by crewmen of the nuclearpowered submarine Theodore Roosevelt by working out in their gymnasium. Necessarily small and stowable, the gym is an inflatable rubber structure that fits into the passageway of the torpedo room, the only available space on the ship. Air at 5 to 10 psi keeps the rubber walls up, providing protection from injury on steel bulkheads. The gym, built by Goodyear Tire and Rubber Co., is 4 ft wide and 22 ft long. Three men can install it in a half hour, and it accommodates a rowing machine, a punching bag, weights, and other athletic equipment.

DRAFTING TRENDS



New, improved Rotolite Expeediter conveniently makes sepia reproducibles and diazo films in addition to low cost whiteprints.

Make your own whiteprints in two minutes or less

Here's a new, fast, economy whiteprinter that fills a real need in small drafting rooms or large engineering departments.

Workprints for architects, consulting engineers, surveyors, contractors. The Rotolite Expeediter can handle all copying needs for the two- or threeman drafting operation, is always ready to cope with rush jobs, even after hours. With Post Super Vapo Papers, print production can be doubled.

Quick checkprints for larger manufacturers. Even huge, multi-department engineering divisions with their own reproduction departments or outside sources praise Expeediter's practical, on-the-spot convenience for quick copies of preliminary sketches, checkprints, conference data, visual presentations. Hundreds of companies have placed Rotolites advantageously in each of their several engineering and drafting rooms for "self-service" white-prints in a hurry.

No preheating or other delays—Rotolite makes prints immediately. There's a choice of three models to take 18", 27" or 42" wide tracings of any length. Furnished with dry-developing ammonia tube. Rotolite is easily hung on wall or placed flat on a table top, plugs into any standard convenience outlet. With new dial speed control, you can make cloth and film reproductions immediately, as well as paper prints. Provides clean, sharp prints every time through simple design, durable construction. Single lamp simplicity is entirely adequate for every "quick print" need.

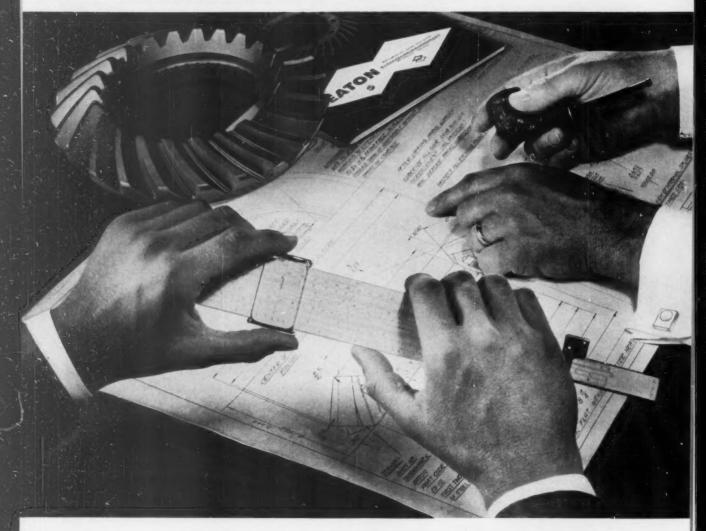
Recommended print materials. Use Post diazotype sensitized products —Vapo paper, sepia vellum, cloth or film—for best results. Get full information on Expeediter and standard Rotolite whiteprinters from your Post dealer or write Frederick Post Company, 2659 N. Ave.

3652 N. Avondale Avenue, Chicago 18, Ill.



SENSITIZED PAPERS & CLOTHS . TRACING & DRAWING MEDIUMS . DRAWING INSTRUMENTS & SLIDE RULES ENGINEERING EQUIPMENT & DRAFTING SUPPLIES . FIELD EQUIPMENT & DRAFTING FURNITURE

Want to TALK GEARS?



get down to brass tacks quickly with a DOUBLE DIAMOND engineer

All Double Diamond representatives are engineers whose specialty is gears. Whether you're in the thinking, planning, or blueprint stage you can get help from a Double Diamond specialist, whether you buy or not. One thing is certain. If you buy, Double

Diamond gears will measure up to your requirements and ours...will produce low installed cost...will serve economically and dependably...will do credit to your product and reputation. A phone call or letter will have you "talking gears" soon.

EATON

AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA



GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Circle 212 on Page 19

Reader Information Service

Circle number on Yellow Card for

- Free catalogs, bulletins, literature
- Information about new parts, materials
- Design data on advertised products
- Extra copies of editorial articles

HELPFUL LITERATURE

Descriptions of items start on Page 233. Starred items are from August 31 issue.

Electrical, Electronic

- 602 Recycling Timer. 2 pp. Industrial Timer Corp.
 609 Integral-Hersepower Motors. 6 pp. Kingston-Conley Inc.
- 612 Wound-Roter Motors. 4 pp. Louis Allis Co. 619 Solderless Terminal Blocks. 4 pp. Thomas & Betts Co.
- 624 AC Meters. 6 pp. Kingston-Conley Inc.
- 626 Diai Timer. 8 pp. Automatic Timing & Controls
- 627 Indicator Tubes. 8 pp. Electronic Components Div., Burroughs Corp.
- 631 Trimming Petentiemeter. 2 pp. Techno-Components Corp. 632 Synchronous Motors. 20 pp. Bodine Electric
- 635 Plastic Protectors. 4 pp. S. S. White, Plastics
- 636 Panel Meter. 2 pp. Helipot Div., Beckman In-
- 641 Armored Cable. 4 pp. Thomas & Betts Co.
- 643 Miniature Pushbuttons. 12 pp. General Elec-tric Co.
- 645 Centrol Synchro. 2 pp. Vernitron Corp. 648 Terminal Panel Wiring Block. 4 pp. AMP Inc. 651 Stendard Relays. 8 pp. Potter & Brumfield Div., American Machine & Foundry Co.
- 653 Synchronous Motors. 12 pp. Ideal Electric & Mfg. Co.
- 655 Adjustment Potentiometers. 4 pp. Trimpot Div.,
- 657 Selenium Rectifiers. 8 pp. Edal Industries Inc. 658 Electronic Timers. 4 pp. Electronic Timer Div., Slip Ring Co. of America.
- 659 AC Capacitors. 16 pp. Aerovox Corp.
- 741 Electronic Transformers.* Advantages for mill-tary applications, effect of design parameters on construction. Bulletin GEA-7121, 28 pp. General Electric Co.
- General Electric Co.

 742 Adjustable Sequence Timer.* Date on MicroAdjustable unit 4-23. 4 pp. Space Instrumentation Div., Technology Instrument Corp.

 743 Wire-Waund Petentiometers.* Performance data
 on 11 single-turn, wire-wound, linear, nonlinear, sine-cosine units. 6 pp. Fairchild Controls Corp. linear, sine trols Corp.
- 74 Governors, Switches.* Covers units with from one to six switching elements. Bulletin 604, 12 pp. Synchro-Stort Products Inc.
 745 Slip Rings; Brush Assemblies.* Typical singrings, brush assemblies, rotory switches, and commutators. 16 pp. Slip Ring Co. of America.
- 746 Magnetic Drives.* Adjustable-speed units with ratings from 50 to 2500 hp. Bulletin 2650, 6 pp. Louis Allis Co.

Hydraulic, Pneumatic

- 601 Ammonia Valves. 12 pp. Henry Valve Co.
- 606 Plastic Caps and Sleeves, 2 pp. Caplugs Div., Protective Closures Co. Inc.
- 610 Glass Fiber-Reinforced Pipe. 16 pp. Fibercast
- 614 Transparent Tubing. 4 pp. Busada Mfg. Corp.
- 615 Quick-Connect Couplings. 8 pp. Snap-Tite Inc.
- 617 Dry Fluid Drives. 20 pp. Dodge Mfg. Corp. 618 Air-Hydraulic Cylinders. 6 pp. Sheffer Corp.
- 623 Pump Fundamentals. 16 pp. Goulds Pump Inc.

- 629 Teflon-Lined Rubber Tubing. 2 pp. Pennsylvania Fluorocarbon Co. Inc.
- 630 Red Wipers; O-Rings. 4 pp. Disogrin Industries, Div., Pellon Corp. 633 Temperature Transmitter. 12 pp. Foxboro Co.
- 639 Pressure Gages. 4 pp. American-Standard Controls Div., Rochester Instrument Plant.
- 640 Miniature Valves. 2 pp. Airmatic Valve Inc.
- 644 Pressure Tubing. 4 pp. Rome Mfg. Co. Div., Revere Copper-Bross Inc.
- 647 Quick-Disconnect Couplers. 4 pp. Bruning Co. 652 Seeled Connectors. 4 pp. Physical Sciences Corp.
- 654 Compressed-Air Filter. 4 pp. R. P. Adoms Co.
- 747 Retary Pumps.* Data on ten sizes of Series K and KE units. Bulletin F-4176, 8 pp. Roper Hydraulics Inc.
- 748 Instrument Goges.* V5 units which indicate draft, pressure, temperature, pneumatic im-pulses. Bulletin 321.11, 12 pp. Republic Flow Meters Co.
- 749 Chemical Process Pumps. Model 3195, available in 11 sizes. 16 pp. Goulds Pumps Inc.
- 750 Fluid Moters.* Orbit motors providing speeds from 10 to 800 rpm. Catalog 2361, 8 pp. Char-Lynn Co.
- 751 Leather Packings.* Design data for a variety of sizes and shapes. Form AD-186, 12 pp. Gar-lock Inc.
- lock Inc.

 752 Air-Control Products.* For autometing in-plant operation and for component use in new products. Catalog 125, 48 pp. A. Schrader's Son Div., Scovili Mfg. Co. Inc.

 753 Breided Hoss.* Flexible bronze hase with Tefion inner core. Bulletin 29, 4 pp. Atlantic Metal Hose Co. Inc.
- Metal Hose Co. Inc.
 754 Compression Tube Fittings.* Covers 25 Items of Ridg-lok tube-fitting line. Catalog 4323, 20 pp. Parker Fittings & Hose Div., Parker-Hannifin Corp.
 755 Pilot Valves.* For pressures to 3000 psl. Bulletin 80125, 4 pp. Oligear Co.

Mechanical Equipment

- 625 Spacer Bushings, Washers. 4 pp. Detroit Ball Bearing Co.
- 634 Ratchet-Wrench Applications. 6 pp. Lowell Wrench Co.
- 756 Geer and Pinion Units.® Discusses more than 200 combinations available. Catalog 3001-C, 10 pp Gries Reproducer Corp.
- 757 Worm-Reduction Gears. * Universal mounting types with 11/s, 134, 2/4, and 3-in. centers. Publication 571 B, 16 pp. Crofts U. S. A.

Assembly Components

- 605 Beryllium Bolts. 16 pp. Standard Pressed Steel
- 621 Spring Washers, 8 pp. George K. Garrett Co.
- 738 Pin-Type Fusteners.* Studs, dowels, high-alloy shear-proof pins, and solid-grooved pin fasten-ers. 4 pp. Driv-Lok Sales Corp.
- 759 Industrial Casters.* Covers truck casters with load capacities from 125 to 15,000 lb each. Form 7161, 4 pp. Foultless Caster Corp.

DESIGN

Manufacturing Processes, Parts

760 Design of Wolded Hangers.* Formulas for de-termining stresses in brackets or hangers arc-welded to a cylindrical element. Booklet 1204.4, 4 pp. Lincoln Electric Co.

- 607 Heat-Resistant Adhesive. 6 pp. Transograph Div., Chart-Pak Inc.
- 608 Metallized Cerumics. 16 pp. American Lava
- 613 Sheets, Rods, Tubes. 6 pp. Continental Diamond Fibre Corp.
- 620 Teflen Products. 8 pp. Allegheny Plastics Inc. 622 Aluminum Inget. 12 pp. Aluminum Co. of America.
- 638 Thermoplastic Materials. 26 pp. Connecut Rub-ber & Plastics Co.
- 649 Polypropylene Material. 12 pp. Avisun Corp.
 761 Paper in Product Design.* Uses and advantages of paper in a variety of applications. 12 pp. Knowlifon Brothers.
- 762 Liquid Sealent.* Loctite sealant applications, selection of grade, methods of applying-form 204c, 8 pp. American Sealants Co. 763 Besigning with Phenolics.* Lists typical applications, design properties. Bulletin CDC-394, 6 pp. Chemical Materials Dept., General Electric Co. ó pp. Cr Electric Co.
- 764 Materials Data.* First in a series on materials

 -covers sintered titonium parts. "Materials
 Scope," 2 pp. Mechanical Research Div.,
 Clevite Corp.
- 765 Laminated Plastics.* Grades and properties, hints for designing with laminated plastics. Form \$1060, 8 pp. Synthane Corp.
- 766 Plastics Properties: End Uses.* Covers Lustrex styrene, Monsonto polyethylene, Opolon vinyl chloride, Lustron SAB and SAN compounds. Plastics Fact File, 16 pp. Monsonto Chemical
- 767 Bronze Alloys.* Classifies 42 Ampcoloy specification bronzes and heat-treated variations in 11 basic categories. Bulletin G-61, 10 pp. Ampco Metal Inc.
- 768 Beryllium-Cepper Red.* Properties of Berylco 10, 25, and 50 alloys. Bulletin R-1200-A, 8 pp. Beryllium Corp.

Design Theory, Techniques

616 Heat-Transfer Problems. 12 pp. Electrofilm

Engineering Dept. Equipment

- 603 Photographic Line, 24 pages. Anken Chemical & Film Corp.
- 604 Pertable Testing Instruments, 8 pp. Weston Instruments Div., Daystrom Inc.
- 611 Tape Recorder-Reproducer. 4 pp. Consolidated Electrodynamics Corp.
- 628 Disc Indicators. 6 pp. Electronics & Instru-mentation Div., Baldwin-Limo-Hamilton Corp. 637 Power Supplies. 16 pp. NJE Corp.
- 642 Analytical Instruments. 28 pp. Philips Elec-tronic Instruments.
- 646 Digital Instruments. 4 pp KinTel Div., Cohu Electronics Inc.
- 650 DC Amplifier; Power Booster. 6 pp. Ridgefield Instrument Group. 656 Shaft-Position Encoder, 4 pp. AR&T Electronics
- 769 Laboratory Instruments.* Electrometers, micro-
- microammeters, microvoltmeter, high-voltage supply, high-megohm bridge. Form 35M, 32 pp. Keithley Instruments Inc.
- pp. Keitniey instruments Inc.
 779 Pressere Trensdeers.* Ultradyne units for use with ambient temperatures to 1000 F. 4 pp. Consolidated Controls Corp.
 771 Brefting Machines, Tables.* Covers five Nestler tables and kit, and seven drafting machines. 4 pp. Ozalid Div., General Aniline & Film Corp.
- 772 Reproduction Processes.* One in a series; covers drafting an Kodagraph reproduction films. "Kodak Compass," 6 pp. Sales Service Div., Eastman Kodak Co.

NEW PARTS, MATERIALS, ENGINEERING EQUIPMENT

Electrical, Electronic

- 662 Miniature resisters are rated 1/8 w, 250 v in temperatures to 100 C. American Components

- temperatures to 100 C. American Components inc.

 686 Germanium pewer trensisters in TO-36 case have wide range of applications. Motorola Semiconductor Products Inc.

 697 AC open meters in hysteresis-synchronous and low-slip induction units. Ashland Electric Products Inc.

 678 Electronic simers offer time delays to 60 sec. Tempo Instrument Inc.

 678 Gless capacities are suited for airborne and space applications. Corning Glass Works.

 683 Pilot-light builb is small, 6-w unit. Large Lamp Dept., General Electric Co.

 686 Epexy-meted resistors range from 1/10 to I w. Key Resistor Corp.

 687 Selenoid-release switchlights are available in 14 circuit types. Pendar Inc.

 688 Pheteselectric scanner system has operating range to 8 ft. Former Electric Products Co. Inc.

- Inc.

 10c.

 10c.
- 706 Selid tentelum capacitors in low-capacitance ratings. Semiconductor-Components Div., Texas

- divided into two sets of contacts. Viking industries Inc.
 726 Circuit breaker is trip-free unit. Cambridge Div., Airpax Electronics Inc.
 727 Transisterized timer uses timing network with no moving parts. Automatic Timing & Controls
- Hydraulic, Pneumatic
- 661 Ministure blewer operates at 3600 rpm. Globe Industries Inc.
 665 Sheft seels incorporate unlitized construction. Gits Bros. Mfg. Co.
 676 Flaw-divider valve with locked stops provides 10 colibrated artes to 60 gpm. Hydraulic-Electronic Div., Fawick Corp.
 672 Adjustable-speed drive for applications with power requirements to 5 hp. Log-Master Services inc.

- 680 Tube fitting for vacuum or pressure applica-tions. Crawford Fitting Co.
 684 Fluid metors in speeds to 2000 rpm and pres-sures to 2000 psi. Denison Engineering Div., American Broke Shoe Co.
 689 Relief velve has capacity of 3000 psi. J. E.
- Myles Inc.
 692 Transparent PVC tubing transmits active chemicals or materials. Newage Industries Inc.
- icals or materials. Newage Industries Inc.
 697 Disconnect coupling is squib-operated unit for pressures to 4000 psi. Pyronetics.
 703 sellows, believe assemblies for gas or liquid

- 703 iseliews, beliews assemblies for gas or liquid transmission lines. Avica Corp.
 704 Rustproofing sill for light-duty use protects steel surfaces. Enthone Inc.
 707 Tube axial fan is 2¼ in. long by 3 in. diam.
 Electro Products Div., Western Gear Corp.
 712 Air-meter has valve mounted on top of cylinder.
 Air Control Div., Lehigh Inc.
 713 Divider-combiner valve for pressures to 3000 psi. Waterman Hydraulics Corp.
 716 Fluid filter for nydraulic couloment has high copacity. Michigan Wire Cloth Co.
 717 Linear actuater has continuously adjustable stroke from 0 to 6 in. Electru-Mechanical Div., Leor Inc.
- Lear Inc.

 721 Central valves provide control for low-flow applications. Valve Div., Minneapolis-Honeywell Regulator Co.

 724 Retary actuator in three models with 50 to 314 lb-in. Mo-Bar Hydraulics Co.

 725 Steinless-steel cylinder is "throw-away" unit with 34-in. bore. Bimba Mfg. Co.

Mechanical Equipment

- 660 Hellow-shaft differentials have backlash of 8 min or less. Instru-Lec Corp.
 643 Saff-aligning bearing is one-piece until in aluminum housing. Bronze Bearings Inc.
 668 Ball-bearing screw assemblies provide high load-carrying capacities. Saginow Steering Gear Div., General Motors Corp.
 677 Needle bearings in eight new sizes. Kaydon Engineering Corp.
 679 Speed-reduction unit for use with small-hp motors. Speed Reducer Div., Barnes Drill Co.
 628 Gasoline engines in either 2.5 or 3.5 hp units. Lauson-Power Products Div., Tecumseh Products Co.
- Products Co.

- Products Co.

 888 Ball joint and pivets are made with a ring bearing and a hollow stud. Link-Age Corp.

 693 Full-time differential has no clutches, springs, or other small parts. Dual Drive Inc.

 699 Serve eeer bexes provide ratios from 2:1 to 625:1. PIC Design Corp.

 701 Miniature bearings have tolerances equivalent to ABEC-5. Barden Corp.

 705 Speed reducers provide reductions of up to 3600:1. Cleveland Worm & Gear Div., Eaton Mfg. Co. 705 Speed reducers provide reductions 3600:1. Cleveland Worm & Geor Div., Eaton Mfg. Co.
 725 Meter-breke has external manual release. Dings Brakes Inc.

Assembly Components

664 Wire markers permit writing of own codes or legends. Westline E-Z Code Div., Western Lithograph Co.

- Descriptions start on Page 250
- 671 Cap screws in lengths from 6 to 30 in.
 Premier industrial Corp.
- Swivel, rigid costers in wheel diameters from
 4 to 12 in. Hamilton Caster & Mfg. Co.
 Fressure-sensitive nemeplates are available in new materials. Allied Decols Inc.
- 685 Hose clamp provides deep-slotted screwdriver slot. Wittek Mfg. Co. 695 Caster wheels have resilient durable tread. Rapids-Standard Company Inc.

Materials

- 667 Silicone resins have metal fillers. Furane Plastics Inc.
- 676 Organic friction material controls brakes and clutches at temperatures to 1000 F. Johns-
- Metallic centing for expanded polystyrene foam.
 Adhesive Products Corp.
- 687 Thermoplastic resin has thermal stability from

 -400 to +400 F. Minnesota Mining & Mfg.
- Co.

 694 Teffen tape has nonstick surface and chemical inertness. Dilectrix Corp.

 799 Vinyl-ceated glass cleth in widths of 36 and 50 in. for high-temperature use. Vulcan Dlv., Reevas Brothers Inc.

 711 Fiber-plestic material for temperatures from —40 to +200 F. Spoulding Fiber Co. Inc.

 712 Reinferced plastic for rocket applications. Advanced Materials Div., Taylor Fibra Co.

 723 Tungsten-rhenium alloys in expanded range of wire and strip sizes. Hapkins Mfg. Co.

Engineering Dept. Equipment

- 729 Calibrated drawing aid has improved index window. Rol-Ruler Co.
- 730 Automatic escillescope has all-solid-state cir-cuitry and digital readout. California Instru-ments Corp.
- 731 Pressure trensducer measures in 0-50 to 0-5000 psia range. Micro Systems Inc.
- 732 Diaze print developer makes prints to 42 in. wide. Rotalite Sales Corp.
- 733 Tracing paper has good reproduction trans-parency. Charles Bruning Co. Inc.
- 734 Photeelectric techometers cover speed range from 100 to 24,000 rpm. Simonds Worden White Co.
- 735 Hand pump for high-pressure static testing. Wm. S. Pine Inc.
- 736 Pertable instruments have taut-band suspen-sion. Westinghouse Electric Corp. 737 Drewing-point sections are now available in sets. Koh-1-Noor inc.

- 738 Torque meter computes relative torque value or ball bearings. Power Instruments Inc.
 739 Semicenductor cooler kit contains complete units and modular components. Delta-T Semi-conductor Cooling Div., Wakefield Engineering
- 740 Copying machine combines diazo and photocopy units. Charles Bruning Co. Inc.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 348 for other available reprints. Editorial content of Machine Design is indexed in the Applied Science Technology Index and the Engineering Index, both available in libraries. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

- 19-1 Computer in a Sheebex. Automatic digital-graphical hybrid that may forestadow "shoe-box control" of an entire industrial process. (4 pp.)
- 19-2 The Engineer in Industry in the 1960's. Re-cent NSPE study probes engineer's main cent NSPE study probes engineer's main problems—salary, unions, recognition of pro-fessional status. (4 pp.)
- Statistical Dimensionine Program. Setting up a program to improve the way assemblies function, while allowing all possible dimen-sional tolerance. (6 pp.)
- 19.4 Flexible Couplings. How to design couplings

- that use an elastomeric flexible element. (6 pp.)
- High-Temperature Brazing Alleys. Properties and applications of nickel-base brazing compositions for high-temperature metals. (4 pp.)
- DC Meter Centrel—Part 5. Descriptions, service classes, and operational concepts of general and definite-purpose controllers. (6 op.)
- Stress Relieving of Steel Weldments Guide to stress relieving; covers some controversial regulations from welding codes. (5 pp.) File-Wrapper Esteppel. A look at a common patent pitfall. (3 pp.)
- Internally Linked Bellows Jeints. Experimentally obtained loss factors for fluid flow in chain-link and gimbol-ring types of internally linked joints. (3 pp.)
- 19-10 Large Plastic Parts. Design guide to Thermo-fusion, new molding technique for fabricating large parts. (3 pp.)
- 19-11 Quadratics-Cubics-Quartics. Three methods, based on nomograms, to get quick, direct answers; procedure for refining roots to any degree of accuracy. (8 pp.)
- 19-12 Selection of M-thods for Cooling Electronic
 Equipment (Abstract). Natural convection;
 forced convection; radiative cooling; liquid cooling, (4 pp.)
- 19-13 Producibility Fectors in Geer-Blank Design (Astract). Selection of materials and produc-tion machine; gear-blank configuration, di-demensional control, heat treatment. (3 pp.)
- 18-2 Engineering and Research Reports.* Develop-ing affective technical reports; seven most

- Important kinds. (6 pp.)
 Flame-Sprayed Coatings.* Four methods of flame-spraying protective coatings; guide to material selection, design of flame-sprayed parts. (11 pp.)
- Critical Speeds of Coupled Machines.* Method for determining the critical speed, or natural lateral frequency, of an entire system. (7 pp.)
- 17-7 Radii of Gyration.* Nomograms for determining K³ where multiple dimensions occur. pp.)
- Wire-Rope Assemblies.* Selecting wire rope from standard types; designing assemblies. (9 pp.)
- Impact Loads.* Predicting effects of suddenly applied loads; designing efficient structural parts. (9 pp.)
- Chemical Cleaning of Metal Parts. Selection considerations; descriptions of chemical met-al-cleaning processes. (8 pp.)
- Gas-Operated Mechanisms.* Nondimensional graphs simplify calculations of velocity, distance, time. (3 pp.)
- New Roller-Chain Horsepower Retines.* Get-ting the most out of the new horsepower and speed ratings proposed by chain monu-facturers (4 pp.)
- Stepped Shafts and Nonuniform Beams.* Pre-dicting deflections at any point in a stepped shaft or variable-section beam. (6 pp.)
- How to Sell Ideas.* Presenting Ideas to man-agement, what sales resistance to expect. (5 pp.)

CARD
INVALID
WITHOUT
COMPANY
NAME
TYPE
OR PRINT

MACHINE DESIGN Sept. 14, 1961

Do not use this card after Nov. 14, 1961

NAM	E												TIT	LE													
сомі	PANY												PRO	DUCT	MANU	FACTU	RED								_		
ADDR	ES\$												CIT	Υ								ZONE		STA	ATE		
201 202 203 204 205	226 227 228 229 230	251 252 253 254 255	276 277 278 279 280	301 302 303 304 305	326 327 328 329 330	351 352 353 354 355	376 377 378 379 380	401 402 403 404 405	426 427 428 429 430	451 452 453 454 455	476 477 478 479 480	501 502 503 504 505	526 527 528 529 530	551 552 553 554 555	576 577 578 579 580	601 602 603 604 605	626 627 628 629 630	651 652 653 654 655	676 677 678 679 680	701 702 703 704 705	726 727 728 729 730	751 752 753 754 755	776 777 778 779 780	801 802 803 804 805	816 817 818 819 820	831 832 833 834 835	846 847 848 849 850
206 207 208 209 210	231 232 233 234 235	256 257 258 259 260	281 282 283 284 285	306 307 308 309 310	331 332 333 334 335	356 357 358 359 360	381 382 383 384 385	406 407 408 409 410	431 432 433 434 435	456 457 458 459 460	481 482 483 484 485	506 507 508 509 510	531 532 533 534 535	556 557 558 559 560	581 582 583 584 585	606 607 608 609 610	631 632 633 634 635	656 657 658 659 660	681 682 683 684 685	706 707 708 709 710	731 732 733 734 735	756 757 758 759 760	781 782 783 784 785	806 807 808 809 810	821 822 823 824 825	836 837 838 839 840	851 852 853 854 855
211 212 213 214 215	236 237 238 239 240	261 262 263 264 265	286 287 288 289 290	311 312 313 314 315	336 337 338 339 340	361 362 363 364 365	386 387 388 389 390	411 412 413 414 415	436 437 438 439 440	461 462 463 464 465	486 487 488 489 490	511 512 513 514 515	536 537 538 539 540	561 562 563 564 565	586 587 588 589 590	611 612 613 614 615	636 637 638 639 640	661 662 663 664 665	686 687 688 689 690	711 712 713 714 715	736 737 738 739 740	761 762 763 764 765	786 787 788 789 790	811 812 813 814 815	826 827 828 829 830	841 842 843 844 845	856 857 858 859 860
216 217	241 242	266 267	291 292	316 317	341	366 367	391 392	416 417	441 442	466 467	491 492	516 517	541 542	566 567	591 592	616	641 642	666 667	691	716 717	741 742	766 767	791 792	ED11	ORIAL	ARTI	CLES
218 219 220	243 244 245	268 269 270	293 294 295	318 319 320	343 344 345	368 369 370	393 394 395	418 419 420	443 444 445	468 469 470	493 494 495	518 519 520	543 544 545	568 569 570	593 594 595	618 619 620	644 645	668 669 670	693 694 695	718 719 720	743 744 745	768 769 770	793 794 795	19-1	11	9 10	17-7
221 222 223 224 225	246 247 248 249 250	271 272 273 274 275	296 297 298 299 300	321 322 323 324 325	346 347 348 349 350	371 372 373 374 375	396 397 398 399 400	421 422 423 424 425	446 447 448 449 450	471 472 473 474 475	496 497 498 499 500	521 522 523 524 525	546 547 548 549 550	571 572 573 574 575	596 597 598 599 600	621 622 623 624 625	646 647 648 649 650	671 672 673 674 675	696 697 698 699 700	721 722 723 724 725	746 747 748 749 750	771 772 773 774 775	796 797 798 799 800	12.4 12.4 12.7 12.7	19	111 112 113 1-3 1-3	16-5 15-3 15-8 14-3 14-8 13-2

CARD INVALID WITHOUT COMPANY NAME TYPE OR PRINT

MACHINE DESIGN Sept. 14, 1961

Do not use this card after Nov. 14, 1961

NAN	E												TIT	LE													
COM	PANY												PRO	DUCT	MANU	JFACTU	IRED										_
ADD	RESS												CIT	Υ								ZONE		STA	ATE		
201 202 203 204 205	226 227 228 229 230	251 252 253 254 255	276 277 278 279 280	301 302 303 304 305	326 327 328 329 330	351 352 353 354 355	376 377 378 379 380	401 402 403 404 405	426 427 428 429 430	451 452 453 454 455	476 477 478 479 480	501 502 503 504 505	526 527 528 529 530	551 552 553 554 555	576 577 578 579 580	601 602 603 604 605	626 627 628 629 630	651 652 653 654 655	676 677 678 679 680	701 702 703 704 705	726 727 728 729 730	751 752 753 754 755	776 777 778 779 780	801 802 803 804 805	816 817 818 819 820	831 832 833 834 835	846 847 848 849 850
206 207 208 209 210	231 232 233 234 235	256 257 258 259 260	281 282 283 284 285	306 307 308 309 310	331 332 333 334 335	356 357 358 359 360	381 382 383 384 385	406 407 408 409 410	431 432 433 434 435	456 457 458 459 460	481 482 483 484 485	506 507 508 509 510	531 532 533 534 535	556 557 558 559 560	581 582 583 584 585	606 607 608 609 610	631 632 633 634 635	656 657 658 659 660	681 682 683 684 685	706 707 708 709 710	731 732 733 734 735	756 757 758 759 760	781 782 783 784 785	806 807 808 809 810	821 822 823 824 825	836 837 838 839 840	851 852 853 854 855
211 212 213 214 215	236 237 238 239 240	261 262 263 264 265	286 287 288 289 290	311 312 313 314 315	336 337 338 339 340	361 362 363 364 365	386 387 388 389 390	411 412 413 414 415	436 437 438 439 440	461 462 463 464 465	486 487 488 489 490	511 512 513 514 515	536 537 538 539 540	561 562 563 564 565	586 587 588 589 590	611 612 613 614 615	636 637 638 639 640	661 662 663 664 665	686 687 688 689 690	711 712 713 714 715	736 737 738 739 740	761 762 763 764 765	786 787 788 789 790	811 812 813 814 815	826 827 828 829 830	841 842 843 844 845	856 857 858 859 860
216 217 218 219 220	241 242 243 244 245	266 267 268 269 270	291 292 293 294 295	316 317 318 319 320	341 342 343 344 345	366 367 368 369 370	391 392 393 394 395	416 417 418 419 420	441 442 443 444 445	466 467 468 469 470	491 492 493 494 495	516 517 518 519 520	541 542 543 544 545	566 567 568 569 570	591 592 593 594 595	616 617 618 619 620	641 642 643 644 645	666 667 668 669 670	691 692 693 694 695	716 717 718 719 720	741 742 743 744 745	766 767 768 769 770	791 792 793 794 795	19-1	19	ARTI	17-7
221 222 223 224 225	246 247 248 249 250	271 272 273 274 275	296 297 298 299 300	321 322 323 324 325	346 347 348 349 350	371 372 373 374 375	396 397 398 399 400	421 422 423 424 425	446 447 448 449 450	471 472 473 474 475	496 497 498 499 500	521 522 523 524 525	546 547 548 549 550	571 572 573 574 575	596 597 598 599 600	621 622 623 624 625	646 647 648 649 650	671 672 673 674 675	696 697 698 699 700	721 722 723 724 725	746 747 748 749 750	771 772 773 774 775	796 797 798 799 800	194	19	A-11 A-12 A-13 B-2 B-3	1643 1543 1443 1444 1449 1347

INVALID
WITHOUT
COMPANY
NAME

OR PRINT

MACHINE DESIGN Sept. 14, 1961

Do not use this card after Nov. 14, 1961

1	NAM	E												TIT	LE													
1	COM	COMPANY PRODUCT MANUFACTURED																										
1	ADDRESS								CITY											ZONE			STATE					
	201 202 203 204 205	226 227 228 229 230	251 252 253 254 255	276 277 278 279 280	301 302 303 304 305	326 327 328 329 330	351 352 353 354 355	376 377 378 379 380	401 402 403 404 405	426 427 428 429 430	451 452 453 454 455	476 477 478 479 480	501 502 503 504 505	526 527 528 529 530	551 552 553 554 555	576 577 578 579 580	601 602 603 604 605	626 627 628 629 630	651 652 653 654 655	676 677 678 679 680	701 702 703 704 705	726 727 728 729 730	751 752 753 754 755	776 777 778 779 780	801 802 803 804 805	816 817 818 819 820	831 832 833 834 835	846 847 848 849 850
	206 207 208 209 210	231 232 233 234 235	256 257 258 259 260	281 282 283 284 285	306 307 308 309 310	331 332 333 334 335	356 357 358 359 360	381 382 383 384 385	406 407 408 409 410	431 432 433 434 435	456 457 458 459 460	481 482 483 484 485	506 507 508 509 510	531 532 533 534 535	556 557 558 559 560	581 582 583 584 585	606 607 608 609 610	631 632 633 634 635	656 657 658 659 660	681 682 683 684 685	706 707 708 709 710	731 732 733 734 735	756 757 758 759 760	781 782 783 784 785	806 807 808 809 810	821 822 823 824 825	836 837 838 839 840	851 852 853 854 855
	211 212 213 214 215	236 237 238 239 240	261 262 263 264 265	286 287 288 289 290	311 312 313 314 315	336 337 338 339 340	361 362 363 364 365	386 387 388 389 390	411 412 413 414 415	436 437 438 439 440	461 462 463 464 465	486 487 488 489 490	511 512 513 514 515	536 537 538 539 540	561 562 563 564 565	586 587 588 589 590	611 612 613 614 615	636 637 638 639 640	661 662 663 664 665	686 687 688 689 690	711 712 713 714 715	736 737 738 739 740	761 762 763 764 765	786 787 788 789 790	811 812 813 814 815	826 827 828 829 830	841 842 843 844 845	856 857 858 859 860
	216 217 218 219 220	241 242 243 244 245	266 267 268 269 270	291 292 293 294 295	316 317 318 319 320	341 342 343 344 345	366 367 368 369 370	391 392 393 394 395	416 417 418 419 420	441 442 443 444 445	466 467 468 469 470	491 492 493 494 495	516 517 518 519 520	541 542 543 544 545	566 567 568 569 570	591 592 593 594 595	616 617 618 619 620	641 642 643 644 645	666 667 668 669 670	691 692 693 694 695	716 717 718 719 720	741 742 743 744 745	766 767 768 769 770	791 792 793 794 795	19-1	19	19-9 17-1 19-10 16-1 19-11 16-1 19-12 15-1 19-13 15-1 18-2 14-1 18-3 14-1 17-4 13-2	
1	221 222 223 224 225	246 247 248 249 250	271 272 273 274 275	296 297 298 299 300	321 322 323 324 325	346 347 348 349 350	371 372 373 374 375	396 397 398 399 400	421 422 423 424 425	446 447 448 449 450	471 472 473 474 475	496 497 498 499 500	521 522 523 524 525	546 547 548 549 550	571 572 573 574 575	596 597 598 599 600	621 622 623 624 625	646 647 648 649 650	671 672 673 674 675	696 697 698 699 700	721 722 723 724 725	746 747 748 749 750	771 772 773 774 775	796 797 798 799 800	19-3 19-4 19-5 19-6 19-7 19-8	19 19 18		

FIRST CLASS Permit No. 36 CLEVELAND, OHIO

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

-POSTAGE WILL BE PAID BY-

MACHINE DESIGN

Penton Building

Cleveland 13, Ohio

Reader's Service Dept.

FIRST CLASS Permit No. 36

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

-POSTAGE WILL BE PAID BY-

MACHINE DESIGN

Penton Building

Cleveland 13, Ohio

Reader's Service Dept.

CLEVELAND, OHIO

FIRST CLASS Permit No. 36 CLEVELAND, OHIO

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

-POSTAGE WILL BE PAID BY-

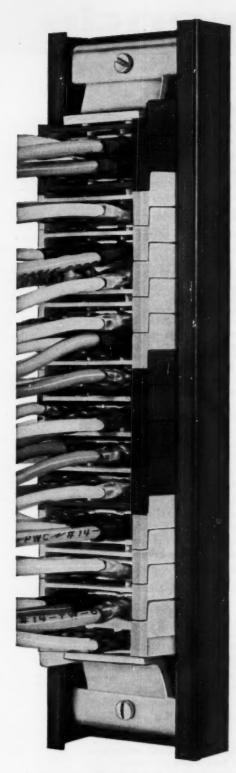
MACHINE DESIGN

Penton Building

Cleveland 13, Ohio

Reader's Service Dept.





HIGH-DENSITY WITHOUT TOOLS!

HIGH-DENSITY WITHOUT TOOLS!

HIGH-DENSITY WITHOUT TOOLS!

HIGH-DENSITY WITHOUT TOOLS!

THE ONE-TRACK

MIND

OF

TERMI-BLOK*

HIGH-DENSITY WITHOUT TOOLS!

HIGH-DENSITY WITHOUT TOOLS!

HIGH-DENSITY WITHOUT TOOLS!

HIGH-DENSITY WITHOUT TOOLS!

* Trademark



TERMI-BLOK* is a brand new concept in terminal blocks. Its design has a single, fundamental motive: to permit high-density power and control circuiting and power distribution, with no tools needed for circuit connections and changes.

TERMI-BLOK functionally replaces all terminal and barrier boards presently in use in switchboards, panelboards and power control of all kinds.

TERMI-BLOK terminal blocks provide higher density per lineal inch of aluminum track for both power and control circuits than other terminal blocks. And TERMI-BLOK permits front-loading of circuit wires (instead of space-wasting horizontal loading) for higher overall density.

Unlike other terminal boards, TERMI-BLOK requires no tools for wiring insertions and withdrawals. Tab terminals, compression-crimped to your circuit wires by a mated AMP hand or automatic tool, can be inserted directly into 3-circuit common or 6-circuit common slotted modules, and can be extracted just as easily, without adjusting screws, bolts, etc. TERMI-BLOK will accept 10-22 AWG wire sizes, will handle 35 amps.

Write today to AMP INCORPO-RATED and receive complete specifications.



AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

trends

materials

Alumination: Heat-Proof Coating for Nonmetallics



Any textile, leather, paper, fabric, or plastic can be coated with aluminum by a new low-cost process called Alumination. The heat-reflecting coating boosts temperature resistance to a high of 2500 F, depending on the base material. It reportedly increases the reflectivity of woven asbestos 20 times. Original texture and pliability of the treated material is retained, with strength and abrasion-resistance considerably improved. Developed by Thermo-Chem Corp., Penndel, Pa., Alumination can be applied to one or both sides of a fabric, is available in a wide range of colors.

POROSITY IS CAST OUT of Alumalloy, a new aluminum alloy developed by Clinton Engines Corp. A "high-density" die-casting process reportedly licks the porosity problem, after the aluminum has been impregnated with copper and zinc. Clinton will use the alloy in a new line of air-cooled engines, where added density of the material will improve bonding of the engine head and its cast-iron liner. Alumalloy also provides better bearing material, eliminates need of cast-in bronze bearings.

BIG GROWTH FOR BERYLLIUM in aircraft and missile applications is predicted by a major supplier, Brush Beryllium Co., Cleveland. Brush has received an Air Force contract to produce 50 beryllium sheets 18 x 48 in., ranging in thickness from 0.02 to 0.06 in. These will provide the basis for subsequent manufacture of standard aircraft-size 36 x 48-in. sheet. During the process, Brush will research several new techniques in surface finishing—an important factor in the quality of finished sheet.

products/processes

Cylinder Liner Saves Oil, Engine



A powder-metal cylinder liner developed by Amplex Div., Chrysler Corp., is claimed to reduce oil consumption by two-thirds and to lengthen engine life. Piston-ring wear is greatly reduced—after a 500-hr, full-throttle test using the new Oilite liner, machining marks on the rings were still clearly visible. Minimum finishing is required in production of the liner. It is a precision powder-metal part that may need only honing. In an engine the aluminum of the cylinder wall infiltrates the wall of the liner and bonds it into place.

Welder for Thin-Gage Metals

A method of welding thin-gage materials is announced by Westinghouse Electric Corp., offering "exceptional speed and versatility at low cost." Included in the new Westing-Arc SA-200 system are a 100 per cent duty cycle, 200-amp silicon diode rectifier power source; an easy-to-handle, 22-oz torch that accommodates mild-steel or stainless wire from 0.025 to 0.047 in. diam; and a wire-drive system which has a speed range of 90 to 424 ipm with standard gearing.

NATURAL WATER PRESSURE could be used in curing skirts for rocket-motor thrust nozzles, according to Fred Fletcher, chief engineer of California General Inc., Chula Vista, Calif. Method would be to wrap the phenolic-impregnated glass skirt around an electrically heated mandrel, cover it with insulation, and lower it to a depth of 2500 ft into the sea, where pressure is 1100 psi.

FIVE-YEAR LIGHT BULBS will replace those that last only three months on emergency telephones and alarm boxes in New York's IND subway system. The new blue lamp, 9 in. long and 1¾ in. in diam, contains three electroluminescent panels sealed in an atmosphere of dry nitrogen. Made to order by Radio Corp. of America, the lamps are expected to save the subway system \$29,400 a year.

Free Ph.D. for Aspiring Engineering Prof

Forgiveable loans for doctoral students who wish to enter engineering faculty careers are being established at Columbia University under a \$50,000 Ford Foundation grant. A maximum of \$10,000 will be available to a student over a three-year period; loans will be forgiven for service on an engineering faculty in the U. S. or Canada.

Government Supports Three-Fourths of Electronic Engineers

A recent survey of the U. S. electronics industry reveals that over three-fourths of all engineers and scientists employed on electronics work are supported either directly or indirectly by government funds. The survey, conducted by the Electronic Industries Association in co-operation with the Department of Defense, shows that of approximately 155,000 engineers and scientists engaged in electronics work, 128,000 or 83 per cent are employed by industry, 12,500 or 8 per cent are working for the Federal Government, and 7500 or 5 per cent are doing research for universities and nonprofit organizations.

atoms

NEUTRON BOMBARDMENT of materials, to evaluate the effects of radiation on their electrical characteristics, will be done at the University of Mississippi under AEC contract. U-M will use a 3-million-volt Dynamitron (positive ion and electron accelerator), developed by Radiation Dynamics Inc., which will supply radiation similar to that produced by radioactive materials and nuclear explosions.

CERAMIC SPONGES are being tested as a new method for disposing of radioactive-liquid wastes. The sponges, developed by Coors Porcelain Co., Golden, Colo., will be soaked in radioactive solutions and dried repeatedly until they absorb a predetermined amount of liquid waste. Heat treatment will then vitrify the sponges, forming glassy spheres in which the dangerous radionucleides are entrapped.



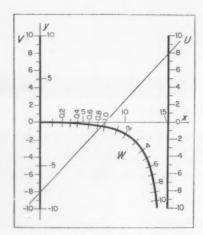
gero/space

NASA Chooses Lunar Launch Site

After surveying a number of possible sites in the U.S. and the Pacific Ocean, National Aeronautics and Space Administration selected Cape Canaveral for launching manned flights to the moon. Approximately 80,000 acres of land will be added to the present Air Force Missile Test Center to permit construction and operation of six or more large Saturn and Nova-class launch vehicle complexes. Nova-class vehicles, which produce as much as 20 million pounds of thrust in the first stage, will require lots of room for launching—an area up to 20 miles in diameter.

SPACE FASTENERS will be developed under a \$350,000 contract awarded Republic Aviation Corp. by the Air Force. Goal is development of rivets, bolts, and other mechanical fasteners—of molybdenum, columbium, and tungsten—that will withstand temperatures from 2000 to 4500 F. Factors to be studied include contamination and oxidation of materials at high temperatures, and effects of vacuum and radiation, acceleration, vibration, heating, and cooling.

FIRST PHASE OF NERVA—Nuclear Engine for Rocket Vehicle Applications—has been started by Aerojet-General Corp. and Westinghouse Electric Corp. Scheduled for completion in six months are preliminary design of the engine; assistance in the design of certain test facilities; preparation of a development plan; research and development work on various systems and components; and study of systems designed to provide safe operation.



If a nomogram for a threevalued equation is placed in a Cartesian co-ordinate system, answer values (U, V, W) lie on a straight line and so have x and y co-ordinates related in a simple linear manner. This permits solution of functions — analytical or empirical—by the techniques of automated nomography.

A remarkable development in automated graphics, backed by the Air Force, may lead to a

Computer in a

DOUGLAS P. ADAMS

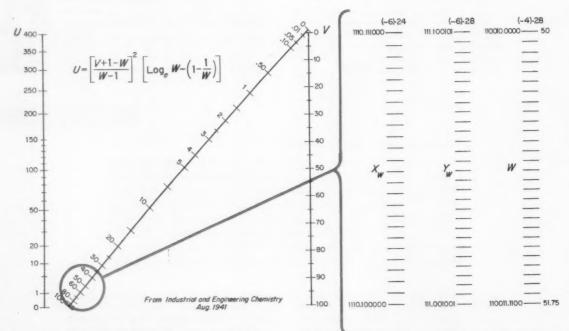
Associate Professor of Engineering Graphics Mechanical Engineering Dept. Massachusetts Institute of Technology

NOMOGRAPHY — a well-seasoned tool for engineering calculation—has joined with electronics to form an automatic digital-graphical hybrid. Called the electronic nomographic computer, this remarkable development may foreshadow the day of "shoebox control" of an entire industrial process.

While still very much in the evo-

lutionary stage (prototype hardware is near test), the electrified nomograph is founded on a sound concept: The use of countable marks. Basic to understanding of such devices is this fact:

In any meaningful drawing or figure, every point shown has associated with it, by express or implied computation, some single value, or a set of values.



Alignment diagrams for an equation of the form F(U,V.W) = O associate value with position on a page. Identification of value through position, or position through value, can be made automatic by electronic counting techniques. Mapping of bits for the W scale produces tracks in the next figure.

These columns of countable marks represent the W scale (Fig. 2) from W = 50 to W = 51.75. Accuracy of the electrified nomograph can be refined by employing higher numbers of countable bits. Higher accuracy naturally implies longer counting times, but there is no theoretical limit to accuracy obtainable.

Shoebox

The associated value causes the point to be placed where it is and enables it, in return, to imply that value (or those values) to the observer. Thus, this value is identifiable by its position, sometimes with and sometimes without the help of a number system. A relationship given in terms of values may give rise to quite a better one in terms of positions.

In the conventional nomograph, scales for each variable are placed, curved, and graduated so that any straight line cuts all scales at values that satisfy the equation of the diagram, Fig. 1.

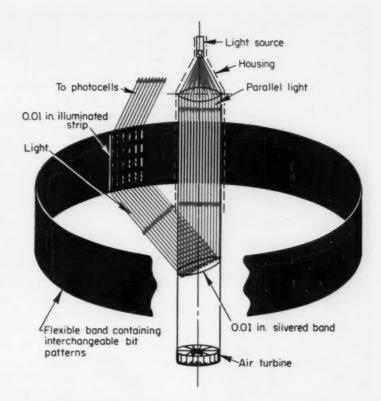
A nomograph for the equation F(U, V, W) = 0, mapped by geometric or determinant methods, can be imagined as imbedded in a Cartesian co-ordinate system. Each scale can then be defined in terms of the variable of that scale. In Fig. 1, for example, the nomogram for the quadratic equation

$$W^2 + UW + V = 0 \tag{1}$$

has been placed in such a way with respect to the Cartesian system that the scales have the equations:

$$X_U = 15;$$
 $Y_U = U$
 $X_V = 0;$ $Y_V = V$
 $X_W = \frac{15W}{1+W}; Y_W = \frac{-W^2}{1+W}$ (2)

It is always possible to get the scales of an existing nomogram in this form, but often impossible to solve for U, V, or W explicitly, or to eliminate the parameter and get $Y_U = Y_U(X_U)$ for the U curve (or for any of the three curves). The following deals exclusively with nomographic equations in the form of Equation 2.



While hardware for the nomographic computer is still in evolutionary stages, development will follow the general principles outlined in this report. Bit counting, for example, may be done optically (above), magnetically, mechanically, or electronically. Study of the device, carried out at MIT, is under the sponsorship of the U. S. Air Force, Rome Air Development Center, Griffiss Field, Rome, N. Y.

It is clear that every meaningful point in Fig. 1 has a value associated with it—that is, each value of the range of U values is associated with a point along the U scale.

Position by Counting

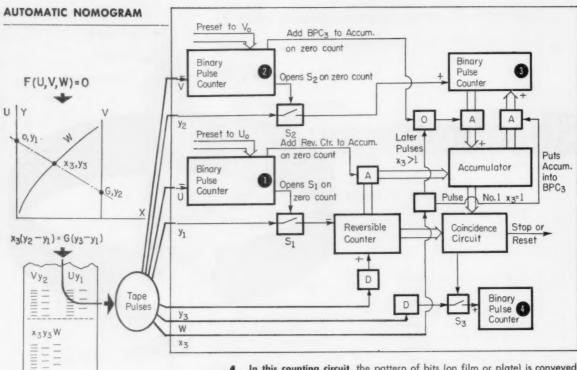
In using the nomogram, some human mind had to identify the points where the input values of U_o and V_o lay, draw a line between them, note the point on the W scale where this line cut, and finally read off the value of W_o there. These steps can be automated if the nomogram is remapped in a way that permits identification of position on a particular scale by means of counting techniques.

The scale for U, in Fig. 1, has the scale equation, Y = U; handed a value of U, the user knows where he should go in Y on the scale to

find that value of *U*. This is the process of association of value with position mentioned above.

If it were necessary or convenient, the user could count up graduations in U, adding one unit at a time for each graduation until the desired value of U was reached. If he were also counting Y graduations, one at a time, he would know his height in Y for any intermediate value of U and for his final U value. The curved scale of Fig. 1 presents just about the same counting problem, except both X and Y counts must be kept track of, and neither of them are uniform.

In Fig. 2, a similar nomogram appears, though for a more difficult equation. Fig. 3 shows three columns of countable marks for a short portion of the curved W scale of Fig. 2, namely from W = 50 to W =



51.75. There are 29 marks in W, with 28 spaces between them. Each space is "worth" 1/16 units of the value of a unit W, with a total increase in the value of W of 28/16 = 1.75. The value of a space (i.e., the increment in W that each space represents) has been chosen, first, as a power of two, namely $1/16 = 2^{-4}$ and, secondly, as a sufficiently low power of two so that graduations can be read to that degree of refinement.

The first choice represents the fact that it will always be convenient to work with numbers in the binary system, where each number is expressed as the sum of powers of two. (In the decimal system, any number is expressed as the sum of powers of ten.) Clearly, an electronic counting device could start at 50, add 1/16 each time it encountered a mark or bit, and it would know where it was on the W scale at every instant.

In Fig. 3, values of corresponding X_W , Y_W , and W counts are along the same level. In both X_W and Y_W columns, the value of a space, that is, the value of the increment in X and Y for each mark, happens to be

4. In this counting circuit, the pattern of bits (on film or plate) is conveyed to and read by a photoelectric cell. U and V pulses are counted as they are received up to the point where they equal input values, U₀ and V₀.

Corresponding Y's, on a parallel column, are counted at the same time and are shut off with the \mathbf{U} , \mathbf{V} counts so that, by the time the first stage of the film has been scanned down to the dotted line, a count of \mathbf{Y}_2 has been built up in BPC3, of $-\mathbf{Y}_1$ in Rev. Ctr., and of their sum in the Accumulator.

As the film below the dotted line is scanned, **W** counts are accumulated in BPC4. On the very first \mathbf{X}_3 pulse, and only on that pulse, the Accumulator amount of $\mathbf{Y}_2 - \mathbf{Y}_1$ is dumped into BPC3. Thereafter, BPC3 goes into the Accumulator with every \mathbf{X}_3 pulse so that at any time there are \mathbf{X}_3 of the quantity $\mathbf{Y}_2 - \mathbf{Y}_1$ in the Accumulator.

The Rev. Ctr., however, holds $\mathbf{Y}_3-\mathbf{Y}_1$, and the Coincidence Circuit opens the switch \mathbf{S}_3 when these two counts are equal, identifying and holding \mathbf{W} , the answer count, in BPC4.

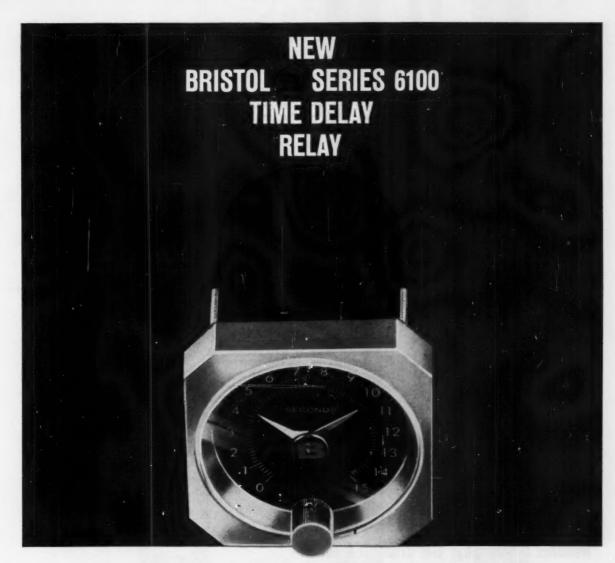
This assembly of counting components was originally suggested by Gene Ott.

the same and is equal to $2^{-6} = 1/64$. This is chosen as the power of two which gives an increment roughly the same size as the given increments in W. The increments are not in step with each other.

Fig. 4 is a schematic diagram which shows how an electronic circuit can take cumulative counts furnished by columns of marks like those described for Fig. 3. At the upper left, the general nomographic form of Fig. 3 appears; the equation in X and Y which must hold between the co-ordinates of the points

where the U, V, and W values occur is also given.

The full cycle of the graphical technique is now evident, Values in U, V, and W are associated with and identified by position on the sheet. An equation difficult in U, V, and W is then easy in X, Y positions, namely a linear relationship in X and Y. Identification of X, Y from U, V, and W is easy through counting mentioned earlier. The patterns of marks in Fig. 4 are for a photoelectric cell; but if recorded upon and read from a magnetic tape,



7 TYPES OF LOAD CIRCUIT OPERATION ALL IN A SINGLE UNIT

Bristol's new Series 6100 gives you easy application with exclusive flexibility. No more complex wiring changes! Make circuit changes in a jiffy, too. You can reach the motor, and other parts—in seconds. The new "Bristol-Vision" dial is mounted in a square die-cast frame—provides better contrast for better viewing plus functional beauty too. Non-scratch bevelled glass dial cover won't buckle, deform—seals against dust. Powered by famous duty-matched standard Bristol motor. Write for brochure.

Contact the Bristol Distributor or Representative in your area.

SEND FOR HANDY TIMING CONTROL PRODUCT DIGEST—complete range of Bristol Motors, Timers and Timing Devices for all your timing and control applications.





LEADING SPECIALISTS IN

AC AND DC MOTORS

— from standard to
special configurations designed to your
specifications.



BRISTOL MOTORS Division of Vocaline Company of America, Inc. / Old Saybrook, Conn.

they would have been present as dots. Other graphical processes show corresponding promise for possible adaptation to the counting technique.

Speed No Problem

A solution time of 1/10,000 sec is being worked toward as within practical limits. What such minute time intervals really amount to is best shown by coupling them with some known large velocities. 1/10,000 sec, the earth moving around the sun at the astronomical speed of 19 miles per second has gone only 10 ft. A satellite or ballistic missile circumnavigating the earth in 90 minutes has traveled only 21/2 ft. Hence computations of such quickness bring even extraterrestrial velocities within operational limits and are obviously germane to existing problems.

There are at least two unpleasantly large flies in this ointment. If 10-million bits can be read, eventually, in one second, then only 1000 can possibly be read in a solution time of 1/10,000 of a second. Is this a large enough number of countable bits to give the resolution

that may be needed for the accuracy desired? The difficulty will be removed, in part, by reading from multiple heads.

If, moreover, there are 10,000 marks to be drawn in a compound problem, it is clear that this unenviable task will have to be mastered by equipment comparable to that employed to read the marks. At this point there is no sense sending a man to do a machine's job. The ways planned for doing this quite naturally involve large computers. One rather promising technique appears to be to program the marks directly upon the scope of the computer and photograph them there. Writing speeds of about three hours per million marks promise to be workable.

The Field is Wide Open

In brief resume of several points of interest, it should be remarked that the case of the nomographic equation involving three curved scales proceeds quite similarly to the one shown above. Natural extensions of the general technique to three or higher-dimensional nomograms is direct and worthwhile. Also, consideration of those cases where solutions lie on something other than a straight line—say a

circle, a parabola, or other linear polynomial—is interesting.

Another important class of possibilities is where an equation in more than three variables can be broken down into a whole series of equations of different variables for which separate nomograms can be made, each contributing to the overall equation. Still another is the very broad field of empirical relations based upon data collected solely from observations. Throughout all this work, the possibility should never be forgotten of projecting a nomogram from one plane onto another through some center of projection of rays in space. This gives another nomogram, because points aligned in the first plane will be aligned in the second. The second diagram can often be arranged to be much more favorable to our techniques than the first.

Unmentioned yet, but clearly obvious, is the fact that the central computing core can accommodate any number of film cartridges representing many such pre-stored solutions in binary bit form. This capability suggests the name, multispecific-purpose computer. With the decreasing size of commercial components, prospects of miniaturization look better and better.

'Needles in the Sky' Get Qualified OK

Washington—Project West Ford, the communications experiment designed to orbit copper "needles," has received the go-ahead from the National Academy of Sciences. Dr. Jerome B. Wiesner, Special Assistant to the President for Science and Technology, has spelled out the ground rules on how the project will be conducted.

Enough needles (dipoles tuned to 8000 megacycles) will be placed in orbit to test the communication-by-microwave-reflection method, but there will not be enough to create headaches for astronomers or other scientists. A thin belt will be erected in a polar orbit at an altitude of a few thousand km. Made up of 75 lb of dipoles, the belt will measure about 8 km wide by 40 km thick 60 days after launch (21 dipoles per cu km). Each dipole will be 1.77 cm long with a diam-

eter of 0.00286 cm, and there will be 3.5 x 10⁸ dipoles involved.

Orbital altitude for the experiment has been chosen to ensure that solar radiation will produce an ever increasing eccentricity, thus bringing perigee into the atmosphere in a few years and consequently destroying the belt.

To be conducted for the government by Lincoln Laboratory (Massachusetts Institute of Technology), the project was first conceived in 1959. At the request of MIT, the Space Science Board of the NAS undertook the job of examining possible effects of the experiment and determining how they would influence the work of other scientists. The Board concluded there would be no adverse effect on any branch of science as long as only one experiment was attempted, but planning for the future must protect the in-

terests of radio and optical astronomers. Further, the Board continued, full scientific and operational information about West Ford should be published as soon as possible, and radio-astronomical research needs the protection of appropriate world-wide agreements.

After digesting the Board's findings, Dr. Wiesner has drawn up the official U. S. policy on the subject:

- No further launchings of orbiting dipoles will be planned until after the results of the West-Ford experiment have been analyzed and evaluated. Conclusions of both foreign and domestic scientists will be considered.
- Decisions to place additional dipoles in orbit will be contingent on both the results of the West-Ford experiment and development of necessary safeguards against harmful interference with space activities.



MIG spot welds: One operator with one machine can do 12 spots per minute.



36

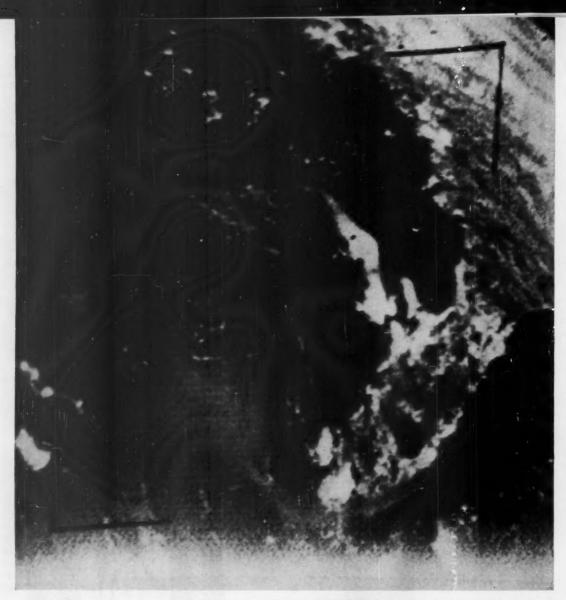
How? Ask Olin:

Olin Aluminum Research has now adapted the MIG welding process for spot welding aluminum; overcoming the old problem of inconsistent results. Where properly designed joints are used, the strength of MIG spot welds is as high as or higher than those of rivets or resistance spot welds, at about half the cost of riveting. No matter what you fabricate—aluminum truck trailers, boats, building products, or the like, Olin Aluminum's technical service may be able to help you adapt their MIG spot welding technique. If you're

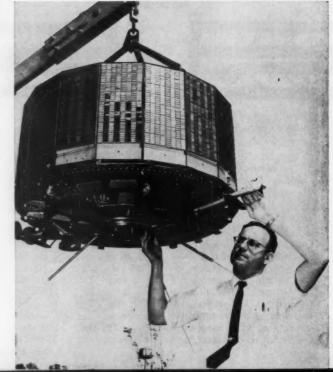
interested in the higher production rate, decreased labor cost and low equipment investment that makes MIG spot welding 50 to 100 per cent cheaper than riveting, call your local Oin Aluminum Sales Office and our expert metallurgical and technical service will be on the way.

Olin ALUMINUM 400 PARK AVE, NEW YORK 22, NEW YORK

Circie 215 on Page 19



Photograph by Tiros III shows a thunderstorm developing off the west coast of Florida. Circling the earth every 98 minutes, the new weather satellite will cover the territory from mid-Canada to lower Argentina. Since its life is expected to coincide with the hurricane season, it should provide valuable advance information on these storms. Tiros III, built by Radio Corp. of America, is similar to its two predecessors—with a few improvements. It carries two wide-angle television cameras instead of one and a narrow-angle unit. It also has a new experimental infrared sensing system to measure heat radiation coming earthward from the sun and that absorbed and reflected by the earth and its atmosphere.



PICTURE REPORT



A three-wheeler for off-the-road use, the Haulster is designed for towing and light hauling. In low gear it develops 470-lb drawbar pul!, providing power to transport a full payload (800 lb) up steep grades and ramps. Top speed of the vehicle is 14 mph. Its wheelbase is 72 in.; turning radius is 90 in. The Haulster is built by Cushman Motors, Lincoln, Nebr., a subsidiary of Outboard Marine Corp.

Aptly named Mercury, this 102-ft yacht can travel at 54 knots. It is powered by three 3500-hp gasturbine engines and carries 25 tons of fuel—enough for a 400-mile trip at 46 knots. The Mercury was built by Vosper Ltd., Portsmouth, England, for Stavros Niarchos, owner of a merchant fleet.





Power-packing pillars is how International Rectifier Corp. describes this package of rectifier cells displayed at the Wescon Show. Each pillar contains 360 rectifiers. Linked to form a "bridge" rated at 35,000 v dc capacity at 55 amp, the super-power devices are used to energize radar early warning systems and in studying energy from nuclear fusion.



Irrigation by solar energy in underdeveloped areas is the aim of a system announced by Westinghouse Electric Corp. A prototype, developed in co-operation with the Solar Energy Laboratory of the University of Wisconsin, produces 50 w of power, converting sunlight into electricity by means of a thermoelectric generator. The electricity is used to drive a motor with a water pump connected to it. Still under development, the 200-w system shown will pump enough water from a depth of 20 ft to irrigate four acres of land with 24 in, of water a year. Daily output is 6000 gallons.

Detailed Study of a Split Personality

In 1955, the National Society of Professional Engineers published a comprehensive study, "A Professional Look at the Engineer in Industry." It provided a searching analysis of the industrially-employed engineer - the effect of National labor laws on his position; his attitudes, satisfactions and dissatisfactions; the union problem and the conflict of philosophies; and proposed means for adequately recognizing his "professional" ambitions. During the intervening years, many changes have taken place, and NSPE has carefully observed the evolution, analyzing it in a new report "The Engineer in industry in the 1960's."1

According to the National Science Foundation, the number of engineers in industry totaled 656,300 in January, 1960. Prospects for the 1960-1970 decade indicate that increases in industrial employment will be filled to a large extent by ever-larger numbers of professional employees.

The development of large engineering staffs, particularly in industry, has been cause of a major dilemma for the engineer. He is a professional employee and wants to be treated and recognized as such. But he is also one of several hundreds, or even thousands, similarly situated within a company. As an employee, he is subject to all rules and regulations, and entitled to all privileges of other employees. But as a professional, he needs a special type of status and recognition, and he wants to be considered and treated as part of the management team. Fulfilling these needs, especially where he is similarly employed with hundreds or thousands of other engineers, is the crucial problem facing management and the profession

Is collective bargaining the solution? Can engineers obtain their objectives through membership and representation by labor unions?

And what of management? What have the companies been doing to encourage professional development and recognition among engineer employees?

The purpose of NSPE's current study is to point out the goals and objectives of the engineer in industry and to offer a program of action, by way of actual examples of company policies, for helping the engineer in industry achieve these goals.

the engineer

- In numbers there is strength
 . . . and a lack of status
- Salary trends are favorable
 . . . especially for beginners

M ONEY, engineer-management relations, and career advancement are topics of perpetual interest in the professional life of most engineers. A description of these factors as they exist in 1960, and their possible course during the next few years, is covered in detail in the recent NSPE study. Here are some of the highlights:

Money: The Compression Problem

The sensational increase in starting rates for engineers coming out of school during the past fifteen years has dramatized the engineering profession as the "fair-haired" boy of the individual-income economy. During World War II, again at the outbreak of the Korean conflict, and particularly since the dawn of the space age in 1957, industry has competed for more engineering graduates than were available. Like any other condition subject to the inexorable law of supply and demand, the price went up.

Unwilling to see their competitors make off with the cream of engineering graduating classes, and apparently less troubled by the prospect of dissatisfaction among their experienced engineers, industrial firms pushed up starting salaries much faster than they did the sal-

aries of experienced men. As a result, while experienced engineers were still getting their raises, they soon found that the gap between their own salaries and those of young graduates working under them was closing, or "telescoping," at a rather alarming rate. The median salary of engineers with 25-years experience dropped from 3.8 times starting salaries in 1939 to 1.9 times starting rates in 1958. For engineers at the 20-year experience level, the ratio decrease was from 3.4 to 1.9.

The most recent salary surveys seem to show an end, and even a slight reversal, to the salary-compression trend. Whether through conscious effort or from the dictates of supply and demand, industrial management has indicated that it may be turning its attention back to the salary needs of the experienced engineer.

This fact is of little comfort to the experienced engineer; as far as he is concerned, the horse has already been stolen, and it will not do him any good to lock the door now. His glow of economic satisfaction is paled by the bright lights of new graduates who seem much too close behind on the salary ladder. The situation may be getting no worse, but to the experienced engineer, it is bad enough already.

References are tabulated at end of article.

in industry in the 1960s

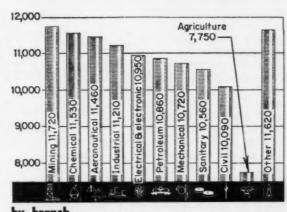
Many observers feel that management has an obligation to keep the compression picture in proper focus. One suggested means: As economic conditions change, the entire salary structure should be adjusted on a percentage basis to avoid loss of salary relationships for experienced professional employees.

Unions: Down, But Not Out

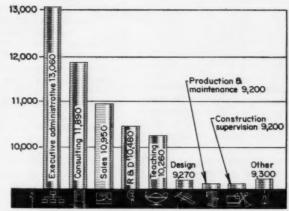
In general, surveys of engineer attitudes toward unionization have indicated an overwhelming opposition to the concept of collective bargaining for professional employees. Unlike some polls, in which respondents say one thing and do another, the actions of engineers in recent years, when faced with a decision on collective bargaining, have conformed to a remarkable degree to their opinions on the subject. Proof of their attitudes toward unionization can be found in their rejection of established engineer unions, plus the failure of unions to form any new significant engineering units in recent years.

A survey in 1953, conducted by the American Society of Civil Engineers, revealed that 63.4 per cent of the engineers questioned were opposed to collective bargaining, while 36.6 per cent replied they were not opposed. However, a

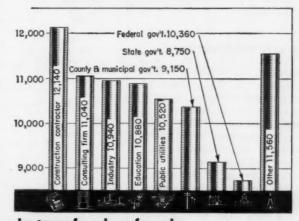
Earnings of professional engineers in 1960 . . .



by branch . . .



by field of employment . .



by type of work performed

1959 survey by ASCE on the same subject showed increased opposition to unionization of professional engineers during the intervening six years. In the latter survey, in response to the question "Do you consider that collective bargaining is, or would be, advantageous to you?" 79.3 per cent said "no," and 16.4 per cent replied in the affirmative.

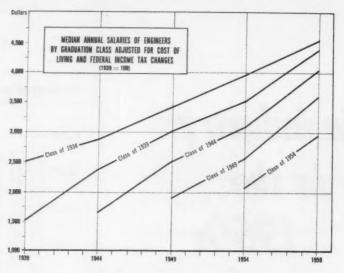
Although it would appear, from the evidence available, that, by and large, engineers sincerely believe unionism and professionalism to be incompatible concepts, industrial management must not assume a complacent attitude. Even with the so-called engineering union movement on the downgrade, the efforts of AFL-CIO affiliates and other trade and industrial unions to organize engineering personnel can keep alive the union approach for solving the problems of engineers in industry. As one noted observer warns:

... if treatment is sufficiently adverse, it could stimulate unionization, notably if the professionals as a group felt that they were being ignored or depreciated by their managers. Barriers to upward communications can engender this feeling, as can poor facilities, delays in responding to professionals' recommendations, failures to recognize their technical contributions to company success, and other signs of managerial indifference.

In short, if many professionals feel that they cannot make progress and earn recognition as individuals, they may be prompted to try to do this collectively.

Career by Parallel Progression

Related to the economic goal of the engineer is the problem of career progression—advancement in engineering or advancement in management. Surveys have shown that many engineers would prefer to continue in engineering work, but most feel that there are more rewards to be gained by moving into jobs outside their technical specialization, such as administration and sales. The belief is common that careers in these areas will permit engineers to become more



Salaries and the Cost of Living

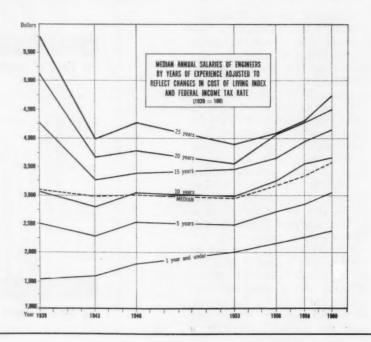
Does the individual engineer have more buying power than he did in the past? Has the profession been keeping up with the cost of living?

Answer to the first question is yes. Generally, most people are far better off today than at any time in the past. The chart above traces salary increases, stated in 1939 dollars and adjusted to reflect Federal income tax changes, of five graduating classes in engineering from 1939 to 1959. While the lines appear to converge slightly (the compression problem), they all go up, and at a very steep rate. If the lines were not adjusted for cost of living or income-tax increases, their

angle of ascent would be about twice that shown on the chart.

Status of the profession as a whole is more complex. But it is evident, from the chart below, that the profession has not been making sufficient gains. The early war years were not kind to engineering . . . between 1939 and 1943, all experience levels, except the one-and-under, lost buying power. Although loss of the profession as a whole was only 4 per cent, the 15, 20, and 25-year experience levels lost purchasing power by 23, 28, and 30 per cent, respectively.

NSPE's data is based on a survey of 24,326 professional engineers.



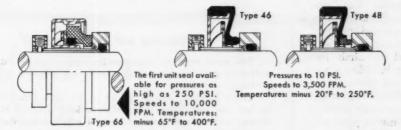
NEW! GITS BRINGS FACE SEALING DOWN TO LIP SEAL COST RANGE

GITS BROS.' Research and Engineering Staff has "cracked the cost barrier" with face type unit* shaft sealing that compares favorably in over-all cost with lip type sealing. This new family of seals (three types) can be an ideal solution in applications where lip seals "don't do the job" or where some face seals are too high-priced.

Consider these economy advantages: low initial cost; no special and costly shaft preparation; simple hand installation (on some models); no shaft wear; seals may be disassembled and the seal faces reconditioned, to effect longer seal life and ease of service "out in the field."

For speed reducers, gear motors, machine tools, construction equipment, home appliances, hydraulic pumps, industrial pumps, aircraft, many other applications. Write for complete Engineering Data File on these and other Gits Shaft Seals.

*Contains both stationary seal face and positive-drive mating ring factory assembled as one unit.



GITS BROS. MFG. Co.

Specialists in Lubricating Devices and Shaft Seals for More Than Half-A-Century

1868A South Kilbourn Avenue Chicago 23, Illinois closely identified with management and will enhance their chances for actually assuming managerial status.

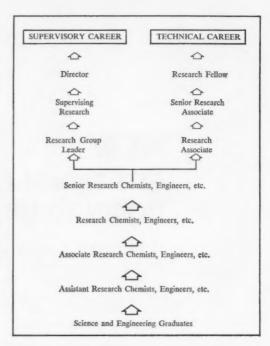
A national survey of 1500 individual engineers, conducted by Deutsch and Shea, Inc., revealed that nearly 80 per cent of the respondents felt that the greatest opportunity for advancement was outside technical specialization. However, when the responses were compared to the career directions to which the engineers were actually committed, only 45.9 per cent indicated they were aiming their careers in the direction of administration; 8.5 per cent had chosen sales; and 43.3 per cent were planning to remain in jobs involving technical specialization despite their belief that advancement opportunities are much greater in the administrative

According to Deutsch and Shea, the trend to regard management as the really attractive alternative to a technical career, from a practical standpoint, is not irreversible. "If some effective measures were implemented which would better equate technical proficiency with the symbols of success, general morale efficiency, and utilization in the technical areas would go up considerably."

A number of industrial employers of engineering personnel have adopted such measures. The Continental Oil Company, for example, has developed a parallel progression plan to permit engineering and scientific personnel to climb the promotional ladder in either a supervisory or technical career.

The company believes its plan offers many advantages, the primary one being that it insures equal advancement opportunities for researchers and engineering specialists who prefer to stay in their chosen technical field. The company further claims that the plan permits engineers and scientists to be promoted to new research positions on the basis of their creative ability and their scientific contributions to the company, and enables outstanding employees to realize long-range career opportunities in the fields in which they were trained. Another important feature of the Conoco plan: It relieves engineers and scientists of responsibil-

Equal advancement opportunities for researchers and engineering specialists who prefer to remain in their chosen field is assured Continental Oil's parallel progression plan. Specialists advance in title and compensation, according to their abilities, without transferring to administrative posts. The plan has worked to the satisfaction of employees and company.



ities associated with the supervision of other persons.

At Western Electric Co. an Engineering Classification Plan has been established to provide appropriate incentives in terms of salary and status to those engineers who achieve their greatest usefulness and personal satisfaction in engineering rather than in administrative work. In terms of compensation, the plan includes a formal "parallel ladder" of advancement which provides in-

dividual engineers the opportunity to achieve salary status ranging as high as that of intermediate levels of administrative management.

REFERENCES

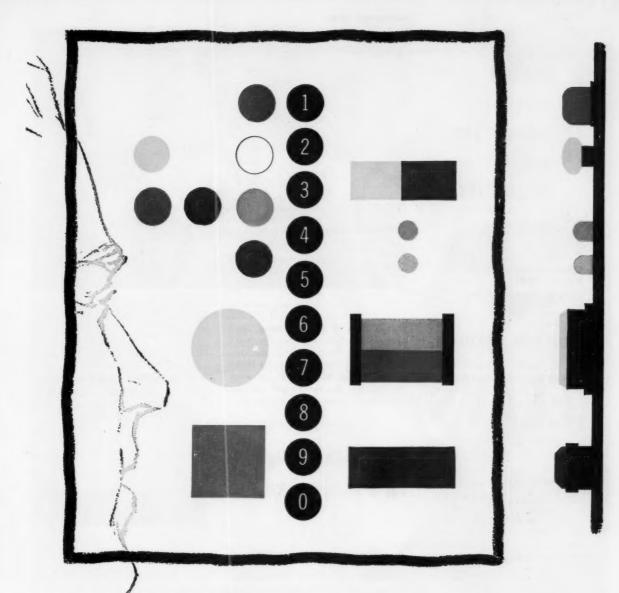
- The Engineer in Industry in the 1960's, National Society of Professional Engineers, 2029 K St., Washington 6, D. C. Price: \$4.00; NSPE members, \$2.00.
- Professional Engineers' Income and Salary Survey, National Society of Professional Engineers, 2029 K St., Washington 6, D. C. Price: \$2.00; NSPE members, \$1.00.

Unionism and Professionalism?

Two noted supporters of engineering unions have all but admitted that professional status stands a good chance of being submerged in the trade-union movement.

Everett Kassalow, research director of AFL-CIO's Industrial Union Dept., has said that group consciousness of professional and other white collar employees "must be translated into clear-cut unionism and not some vaguely-concealed in-between body." He adds: "I am convinced that one reason why some of the white collar engineering unions of the past decade collapsed was their failure to develop among their members a clear-cut acceptance that a union must act and regard itself as a union. Attempts to cover this with the notion that the organization is of a purely professional character and/or an arm of management will not stand up in the long run before aggressive management."

Professor Jack Barbash of the University of Wisconsin, who formerly held Kassalow's post with the AFL-CIO, observed that increasingly, the white-collar employee—from the sales clerk to the professional engineer—is nothing more than a statistic and a payroll item. Consequently, he believes that engineers and other white-collar employees must get used to the idea that their only salvation lies in unionism and he is convinced that, once organized, they will come to accept traditional union values and tactics. According to Barbash, "Once the white collar worker gets over the initial trauma of being in a union he behaves like a bricklayer."



IMPACT!

When a light comes on ... or changes color ... it immediately draws attention. Then add operator reaction ... ''hit that light when it turns red!''. These are basic elements of today's sophisticated control panels.

Attention and reaction are built into all Control Switch lighted pushbutton switches. Round or rectangular buttons that light up in one, two, three or four colors, with monitor and control of up to four circuits.

For monitoring only, Control Switch indicator lights are available in hundreds of sizes, shapes, colors and circuits.

Write today for technical data on the industry's most versatile and complete line of lighted switches and indicator lights. If you have an unusual panel problem, let us solve it with a custom design.

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION

4214 W. Lake St. Chicage 24, Iff.
Telephone: Van Buren 6-3100 • TWX CG-1400
Manufacturers of a full line of switches, controls
and indicators for all military and commercial
applications. All standard units stocked for immediate delivery by leading parts Distributors.

shortest distance between you and RELIABILITY!



INDUSTRIAL TIMER CORPORATION

division of

RELAYS

FOR EVERY APPLICATION

Factory Tested for Reliability!

GENERAL PURPOSE Open Type Relay. Up to 3PDT, 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin. 10.



GENERAL PURPOSE Plug-In Type Relay. Contact arrangements up to 3PDT. 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 10.

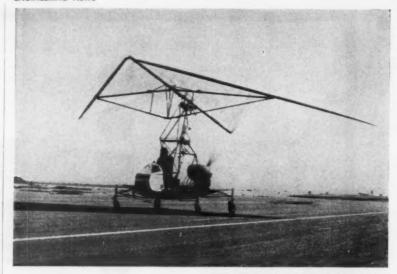


PRINTED CIRCUIT Open Type Relay. Up to 3PDT. 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 11.



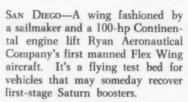


211 River Street, Orange, N. J.
Industrial Relays, Foot Switches, Buzzers, Coils
Phone: ORange 2-8200



Closest thing to the Flex Wing, says test-pilot Lou Everett, is Otto Lilenthal's hang gliders flown early in the century. Testing the vehicle under NASA contract, Ryan Aeronautical Co. envisions huge flexible-winged vehicles capable of recovering 50-ton boosters.





According to Ryan, the kite-wing configuration has remarkable potential for sustaining manned or unmanned vehicles, powered or unpowered. The flexible wing itself has been tested by NASA (in free flight and wind tunnel) from speeds in the low subsonic to Mach 4.9; tunnel altitudes reached 200,000 ft.

Wing for the flying test bed is Mylar bonded to nylon; it hangs loosely between a longitudinal aluminum keel and tubular leading edges flexibly joined at the front end of the keel. For high-speed high-temperature flight, the wing could be fine-mesh wire cloth.

The Flex Wing is primarily a



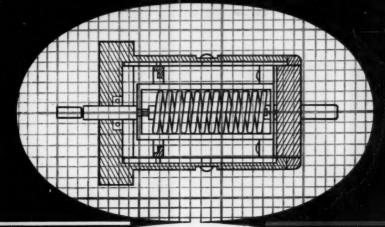
two-control vehicle (pitch and roll). Although lacking a rudder, it has high directional stability and exhibits no tendency to sideslip in a bank. For rising and descending, the wing is pitched relative to the platform by use of a conventional control column.

Reporting on flight behavior, Lou Everett, Ryan's Flex Wing project engineer, described his sensations as "best explained by imagining yourself sitting in a rocking chair controlled by a giant hand which occasionally rocks you sideways as well as back and forth . . . you feel an up-and-down motion integrated with forward velocity, similar to that in a helicopter.

"As for the rocking sensation, I quickly realized—and this was confirmed by motion pictures—that this motion is confined to the platform, confirming the fact that the machine as a whole has strong stability.

When you specify

Drafting costs are cut in half



Quickly and accurately rendered to scale with blue grid lines to guide you. Guide lines are on back of drawing surface enabling you to erase and erase without disturbing them.

THIS IS YOUR PRINT

Blue grid lines have disappeared completely giving sharp, easy-toread copies.

Try Clearprint's perfect
working surface with a 2H
pencil – then with a pen.
Lines are sharp and clear.
Erase and draw the lines again
and again. Now hold Clearprint to a
light and make reproductions. No ghosts!
Then test your present sheet.

Ask our representative or write us regarding Clearprint's revolutionary new "Pre-Print" which pre-prints your basic standards, typical details, title blocks, and bills of material. Their application to your particular needs can save thousands of dollars in drafting and lettering time!



Clearprint is Watermarked For Your Protection

CLEARPRINT : APER CO. MD-158
1482 - 67th Street, Emeryville, Calif.

Please send me sample Clearprint
"Fade-Out" sheets, with prices.
Send me Clearprint samples, with prices, for the following uses:

Have your representative call at my office to discuss special applications for my particular needs.

NAME
FIRM



"Before-and-after" show two pressure vessels fabricated of 301 stainless steel. Vessel at the left is unstretched, has a nominal tensile strength of 102,000 psi. The one on the right, stretched approximately 13 per cent of its diameter, is toughened to a tensile strength of 260,000 psi.



Stretched near absolute zero . . .

Stainless Shapes Double Their Strength

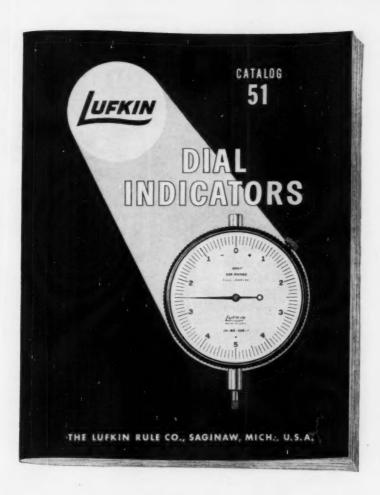
Paramus, N. J.—Cryogenic stretching, a new metalworking process that significantly boosts strength and ductility of many welded shapes, lowers the cost of fabricating stainless steel to less than that of fabricating and heat treating low-alloy steel. Called Ardeforming by the developer, Arde-Portland Inc., the technique involves welding a cylinder, pressure vessel, etc., cooling it with liquid nitrogen, and then stretching it by expansion of gaseous nitrogen.

Vessels fabricated from Type 301 stainless steel have been stretched 13 per cent at -320 F. Tensile strength went from 102,000 to 260,000 psi, and yield strength approached 240,000 psi.

With suitable design and material selection, Ardeformed units could have nominal tensile strengths in the 400,000-psi range, according to A-P research director Ben Aleck. Strength-to-density ratios could reach 1.4 million in. So far, com-



Major difference between Ardeforming and other sub-zero forming processes is that the welding is done first. In the other techniques, much of the ductility and tensile-strength improvement is lost when the worked material is welded. In Ardeforming, welds and base metal are both work strengthened at cryogenic temperatures.



Your copy is FREE

New required reading for designers who specify precision measuring equipment

Your surest source of quality measuring equipment is Lufkin... new leader in precision tools. This catalog shows and describes the comprehensive line-up of Lufkin Dial Indicators... part of a complete line of precision measuring tools available to you as original equipment. When you specify Lufkin you are assuring yourself of accuracy, dependability and long, trouble-free operation. Check on the reader inquiry card for your free copy.

Measure for measure, the finest made...



Circle 220 on Page 19

LET MUELLER MAKE IT!

Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its men, methods and metals . . . Mueller is in the unique position of being able to offer true single source service.

MUELLER HAS THE MEN... experienced engineers with the ability to work out, creatively, tough design problems, and improve a part or components for production by the most economical method. You get sound engineering plus 44 years of practical metalworking production experience when you "Let Mueller Make It."

MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

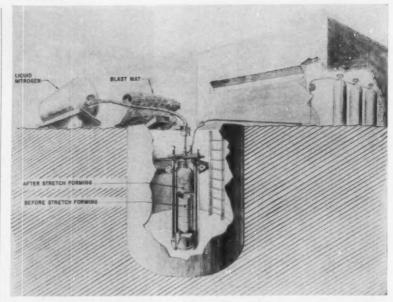
MUELLER HAS THE METALS... and the materials ... to produce precision parts in aluminum, brass, bronze, copper, iron, and steel in hundreds of different alloys to meet each exact requirement.

In addition, Mueller Brass Co. has complete and modern facilities for performing all types of finishing and sub-assembly operations. Another plus value is nation-wide sales engineering service.

So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers... and no matter where you're located, it will pay you to LET MUELLER MAKE IT!



MUELLER BRASS CO. PORT HURON 20, MICHIGAN



First step in the Ardeform process is to fabricate an undersized pressure vessel. Good weld quality must be maintained to permit the stretching that later takes place. The vessel is then placed inside a forming die within the forming tank; tank and vessel are filled with liquid nitrogen, and the vessel is sealed except for a pressurizing line which leads to a compressed-nitrogen supply. The outdoor pit is covered with a blast mat. Once the vessel has reached liquid-nitrogen temperature, the pressurizing line is opened. After the vessel stretches to die dimensions, nitrogen gas is vented off and the vessel is removed for final machining.

pany researchers have been working primarily with Type 301 stainless, but they have also experimented with 302 and 304 steels. Ardeforming appears best suited to 301 because the material achieves maximum strength with minimum working. However, 302 may be preferable in applications where greater localized ductility is desired in the prestretched shape. Other experiments are being performed with aluminum and titanium, and results, while preliminary, appear promising.

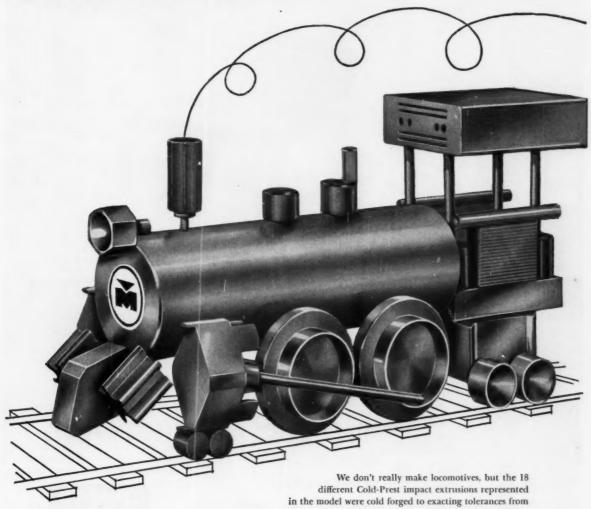
First application for Ardeformed metals seems likely to be in engine casing: for solid-propellant rockets. The 301 shells are reported stronger than the heat-treated 4130-steel cases now used, and estimates show that a 15 per cent cost savings is possible. When compared to shells having the same tensile strength (fabricated from vacuum-melted D6AC steel) cost savings approach 38 per cent. Other advantages of the Ardeformed shell include:

 Weight savings of 1000 lb for solid-propelled missiles in the ICBM class, more for space vehicles. • Rocket cases of almost any size can be built. Because heat treating is not required, the cases are not limited by the size of the furnace.

• During fabrication of the basic vessel, out-of-roundness, straightness, and diameter dimensions need not be closely controlled because the stretching operation removes all kinks, bends, dents, and distortions.

Outside the aerospace field, the Ardeform process has a number of applications. Highpotential strength torpedo cases for the Navy are one of the ordnance jobs being considered; in the civilian world, tubing of varying cross sections, structural members for portable or field-erected bridges and for framework in large trucks and trailers are obvious applications. In the chemical-process industries, Ardeform is expected to find application in pressurized storage vessels used to transport liquids and gases. According to Harman Hugo, president of A-P, the press of immediate defense needs has permitted only light studies of relatively obvious applications. Market-research will turn up many more applications.

MUELLER CAN MAKE MOST ANYTHING IN IMPACT EXTRUSIONS...



a number of aluminum, copper, brass, and steel alloys.

These parts are employed in products ranging from door closers to missiles. Mueller has also made important advances in the production of copper impact extrusions that are especially adaptable to electronic applications. Cold forgings are precision produced to exacting tolerances and offer the additional advantage of a better finish and appreciable metal savings.

Mueller's flexible facilities for the production of Cold-Prest Impact extrusions make practical long or short runs of simple or relatively complex shapes on an economical basis. In addition, the entire Mueller engineering staff, excellent machining, finishing and assembly facilities are readily available to you when you . . .

LET MUELLER MAKE IT!



MUELLER BRASS CO.

PORT HURON 20, MICHIGAN

Write today for Engineering Manual No. FM-3019





Wire-wound, Sealed in Silicone-Ceramic

NEW MIL-R-26C AMENDMENT 2 IN BRIEF: By means of this new amendment, specification MIL-R-26C is extended to include three sizes of insulated, wire-wound resistors with axial leads. The new insulated resistors meet all requirements of MIL-R-26C including a dielectric strength test (1000-volt, V-block) and an insulation resistance test (1000-volt, V-block). Currently, tolerance is specified as 5%.

INSULATED RESISTOR CONSTRUCTION: A single layer of resistance alloy wire is wound on a ceramic core. Metal end caps, with axial leads attached by welding, are then fitted snugly over each end of the core. A molded jacket of silicone-ceramic material completes the unit by sealing the entire assembly.

Through research and advanced production know-how, Ohmite is able to introduce this advanced product line to meet the demanding new requirements of its Military and Industrial customers.

Mil. Des.	Char.	Temp.	Watts	Resist. Range*	L = .020"	D ± .020
RW67	V G	350° C 275° C	6.5 5.0	0.10 to 3600 ohms	0.917"	0.323"
RW68	V G	350° C 275° C	11.0 8.0	0.10 to 8200 ohms	1.823"	0.343*
RW69	V G	350° C 275° C	3.0 2.5	0.10 to 910 ohms	0.542"	0.230"

*MIL-R-26C limit for single-layer winding.

RESISTORS SHOWN TWICE SIZE



Anticipating Industry's Needs In Quality Components

All Sizes and Values Available From Distributor or Factory Stock— Write for Bulletin.

OHMITE MANUFACTURING COMPANY 3618 Howard Street, Skokie, Illinois

Rheostats • Power Resistors • Precision Resistors • Variable Transformers • Tantalum Capacitors • Tap Switches • Relays • R.F. Chokes • Germanium Diodes • Micromodules

Meetings and Shows

Sept. 24-26-

Steel Founders' Society of America. Fall Meeting to be held at the Homestead, Hot Springs, Va. Further information can be obtained from the society, 606 Terminal Tower, Cleveland 13, Ohio.

Sept. 24-27-

American Society of Mechanical Engineers—American Institute of Electrical Engineers. National Power Conference to be held at the St. Francis Hotel, San Francisco, Calif. Additional information can be obtained from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Sept. 24-27-

American Society of Mechanical Engineers. Petroleum Mechanical Engineering Conference to be held at the Muehlebach Hotel, Kansas City, Mo. Further information is available from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Sept. 25-28-

Association of Iron and Steel Engineers. National Convention to be held at the Penn-Sheraton Hotel, Pittsburgh. Further information can be obtained from society head-quarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

Oct. 3-6-

Seventh Annual U. S. Army Human Factors Engineering Conference to be held at the Institute of Science and Technology of the University of Michigan, Ann Arbor, Mich. Additional information can be obtained from Office of Technical Liaison, Office of the Chief Signal Officer, Department of the Army, Room BD1024, The Pentagon, Washington 25, D. C.

Oct. 5-7-

American Society of Mechanical Engineers—American Institute of Mining, Metallurgical, and Petroleum Engineers. Fuels Conference to be held at the Dinkler Tutwiler Hotel, Birmingham, Ala. Additional information is available

from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Oct. 5-8-

American Society of Industrial Designers. Annual Meeting to be held at the Ambassador Hotel (Oct. 5) and the St. Catherine Hotel (Oct. 6-8), Santa Catalina Island, Calif. Additional information can be obtained from Richard M. Wilkes & Associates, 521 N. La Cienega Blvd., Los Angeles 48, Calif.

Oct. 9-11-

National Electronics Conference to be held at the International Amphitheatre, Chicago. Additional information is available from conference headquarters, 228 N. La Salle St., Chicago 1, Ill.

Oct. 9-13-

Society of Automotive Engineers Inc. National Aerospace Engineering and Manufacturing Meeting, including engineering display, to be held at the Ambassador Hotel, Los Angeles. Further information can be obtained from SAE, 485 Lexington Ave., New York 17, N. Y.

Oct. 9-15-

American Rocket Society. Sixteenth Annual Meeting and Space Flight Report to the Nation to be held at the Coliseum, New York. Additional information can be obtained from society headquarters, 500 Fifth Ave., New York 36, N. Y.

Oct. 10-12-

American Standards Association. Twelfth National Conference on Standards to be held at the Rice Hotel, Houston. Further information is available from ASA head-quarters, 10 E. 40th St., New York 16, N. Y.

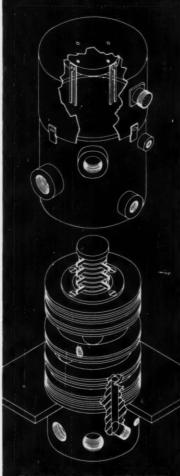
Oct. 15-19-

Technical Association of the Pulp and Paper Industry. Engineering Conference to be held at the Shoreham Hotel, Washington, D. C. Additional information is available from J. Winchester, 360 Lexington Ave., New York, N. Y.

Oct. 17-18

American Society of Mechanical Engineers. Materials Handling Con-

IMAGINATION FOR SALE!



CIRCLE OF POWER

UH-designed swivel assures a "circle of power" for an aerial lift by carrying two high pressure hydraulic lines, tank line, air line, and seven electrical lines from base to rotating superstructure. Operator in aerial bucket has complete freedom and flexibility of movement, can rotate 360° continuously. Some machines have only limited rotation in either direction. Whether your hydraulic problem is complex or commonplace...call or write UH today.

UNIVERSAL HYDRAULICS

DIVISION OF HOLAN CORPORATION 4501 BEIDLER ROAD WILLOUGHBY, OHIO PHONE: 946-2100

Circle 223 on Page 19

ference to be held at the Pick Nicolette Hotel, Minneapolis, Minn. Further information can be obtained from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Oct. 17-19-

American Society of Mechanical Engineers—American Society of Lubrication Engineers. Joint Lubrication Conference to be held at the Morrison Hotel, Chicago. Further information is available from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Oct. 18-20

Gray Iron Founders' Society. Annual Meeting to be held at the Royal York Hotel, Toronto, Canada. Additional information is available from society headquarters, National City-E. 6th Bldg., Cleveland 14, Ohio.

Oct. 19-21-

National Society of Professional Engineers. Fall Meeting to be held at the Hotel Roanoke, Roanoke, Va. Further information can be obtained from NSPE, 2029 K St., N.W., Washington 6, D. C.

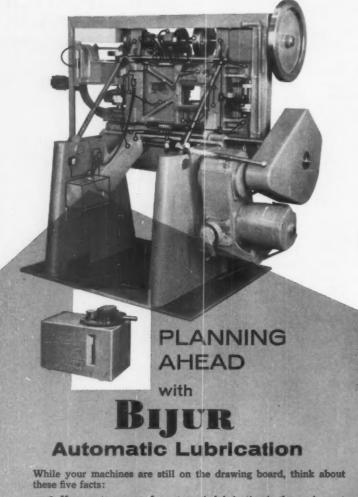
Short Courses and Symposia

Oct. 3-6-

Ninth Annual Human Engineering Institute, conducted by Dunlap and Associates Inc., to be held in Stamford, Conn. The program will consist of three days of technical sessions, a half-day on management and contractual aspects of human engineering efforts, and an opportunity for private conferences. Further information is available from Dr. Jerome H. Ely, Institute Director, Dunlap and Associates Inc., 429 Atlantic St., Stamford, Conn.

Oct. 5-6-

Research and Development Administrators Workshop to be held at the University of Wisconsin. There will be three talks and a session during which problems of the group in attendance will be discussed. Topics scheduled deal with making research and development effective in



- Your customers prefer automatic lubrication in the equipment they buy because it increases production, extends machine life, and lowers operating costs.
- Bijur Automatic Lubrication virtually eliminates bearing failure, a major cause of break-down . . . and customer dissatisfaction.
- Bijur Automatic Lubrication systems, moderate in cost, offer a major sales feature.
- Bijur has been known and trusted for over 35 years by machine builders and machine users alike.
- Bijur lubrication engineers are ready to offer design and technical assistance whenever needed.

Why not write for information on how to plan Bijur Automatic Lubrication into your equipment on the board? It will prove worth while in sales acceptance when your machines are on the floor.



BIJUR LUBRICATING CORPORATION

157 West Passaic Street • Rochelle Park, New Jersey Pioneers in Automatic Lubrication

(2) 4216

company leadership, how to help R & D managers to be more effective on the job, and the development of an effective research and development department. Further information is available from the Management Institute, University of Wisconsin Extension Div., P. O. Box 2098, Madison 5, Wis.

Oct. 10-11-

Seminar on Manufacturing with Space-Age Metals, sponsored by the American Society of Tool and Manufacturing Engineers, to be held at the Sheraton Hotel, Philadelphia. Further information is available from Gilbert E. Seeley, Education Director, ASTME Headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Oct. 11-

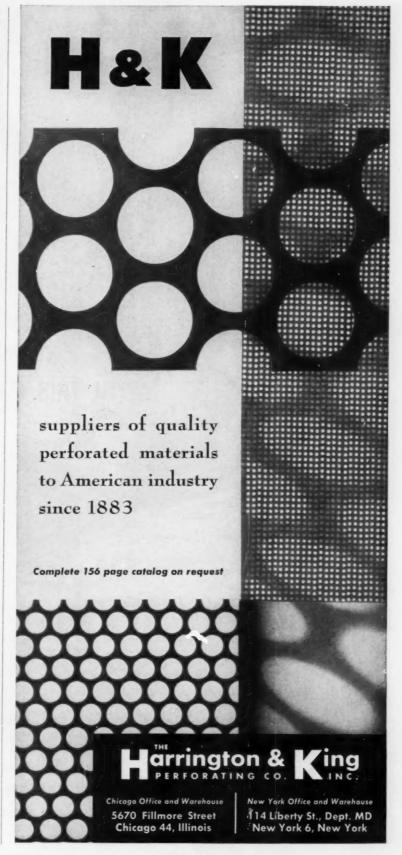
Fall Symposium of the Institute of Printed Circuits, to be held at the Sheraton-Chicago Hotel, Chicago, will be devoted to discussion of molecular electronics. The program is aimed at management, as well as technical, personnel. Additional information is available from Institute of Printed Circuits, 27 E. Monroe, Chicago 3, Ill.

Oct. 25-26-

Computer Applications Symposium, sponsored by Armour Research Foundation, to be held at the Morrison Hotel, Chicago. User experience in computer application and programming techniques will be emphasized. Additional information is available from Benjamin Mittman, program chairman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 29-31-

International Symposium on Photoelasticity to be held at the Illinois Institute of Technology. Sponsors are IIT, four government and military groups, and five technical societies. Twenty papers will be presented on topics including photoelasticity, photoplasticity, photoplasticity, photoelasticity, and special equipment. Additional data can be obtained from M. M. Frocht, Research Professor of Mechanics, Illinois Institute of Technology, Chicago 16, Ill.





1 To provide controlled interference (locking	a. \square always b. \square sometimes c. \square never seize, gall or remove plating from bolt threads.		
torque) with bolt threads, the nylon locking insert of an Elastic Stop nut has an I. D. that is a. \(\sum undersized \) b. \(\sum same size \) in relation to major diameter of standard bolts.	An Elastic Stop nut can be a. \(\sum more accurately \) b. \(\sum less accurately \) prestressed than an all-metal nut.		
2 As bolt threads enter the nylon locking collar they a.	Regardless of vibration, impact or stress reversal an Elastic Stop nut will stay put a. anywhere on the bolt. b. only when torqued against the work.		
3 An Elastic Stop nut a. ☐ increases b. diminishes c. ☐ eliminates wear producing axial play between bolt and nut.	9 Fuels, lubricants, moisture a. □ can b. □ cannot seep past the chemically inert locking collar to cause corrosion of internal bolt-nut threads.		
Upon removal from the bolt, the nylon collar of an Elastic Stop nut a. □ retains its thread impressions. b. □ tends to resume its original shape.	The single-unit Elastic Stop nut costs approximately a. \(\subseteq more \) b. \(\subseteq the same \) c. \(\subseteq less \) to install than a castellated nut and cotter pin, or a double nut.		
(5) A nylon insert Elastic Stop nut can be re-used without losing its locking torque a. □ 10 times b. □ 25 times c. □ over 50 times	Check Your Score 1 a. 2 b. 2 c. 3 b. 2 c. 6 c. 2 a. 3 a. 3 b. 18 c.		
Write Dept. S62-94 for Elastic Stop nut Bulletin describing hundreds of Elastic Stop nut hex shapes and	sizes—from 0-80 to 4"—in carbon and stainless steels, brass, aluminum and other alloys, in all standard finishes.		

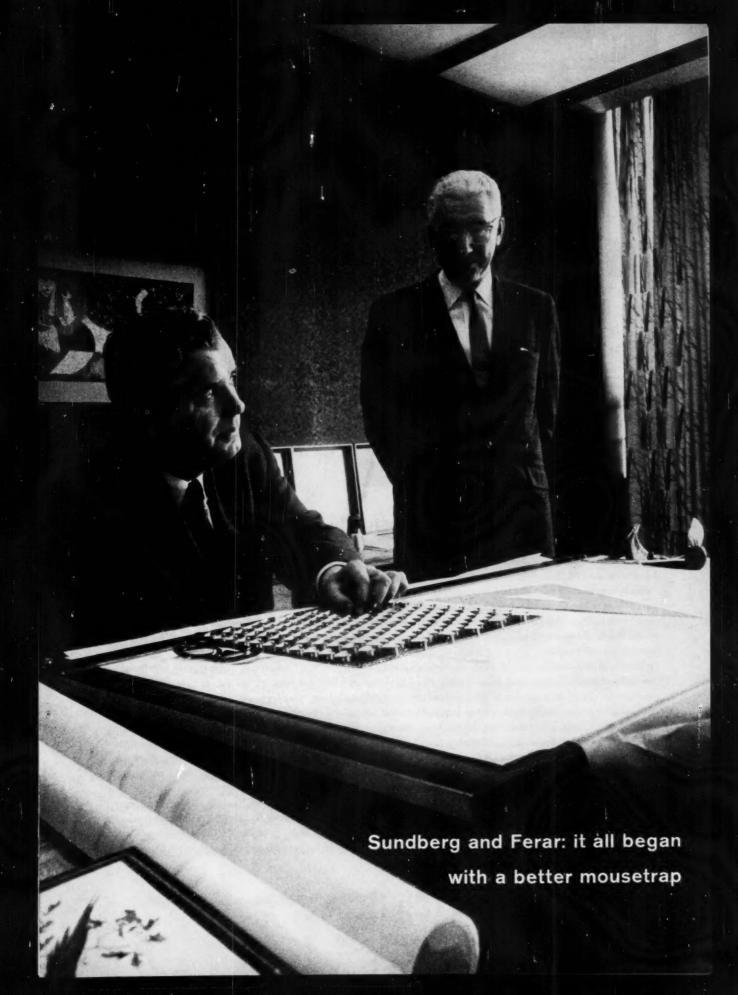


ELASTIC STOP NUT CORPORATION OF AMERICA 2330 Vauxhall Road, Union, New Jersey

for the ring of



reliability









Sundberg and Ferar talk design

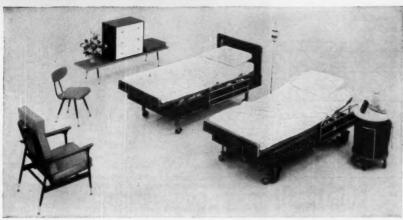
When Carl Sundberg and Montgomery Ferar were getting their design firm started during the depths of the depression, one of their first jobs was to build a better mousetrap. It had four holes, and they called it the "Mouseoleum." It sold well, and started them on their way. Today, Sundberg-Ferar is the largest appliance design firm in the United States—7 associates and 70 designers work in an ultramodern headquarters building near Detroit. Over the years, Sundberg and Ferar have never swerved from their premise that the American public has basic good taste. Give shoppers a choice between good and bad and they'll generally pick the better-designed product.

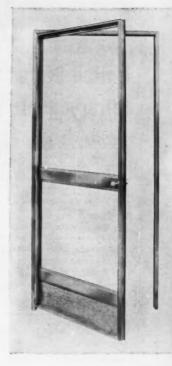
Carl Sundberg contributes a wide range of experience to the firm with a background of art schools and factory production lines. The spectrum of their abilities approaches the complete with Monte Ferar, MIT honor graduate and holder of two degrees in architecture. Since their early days, they have designed products as varied as the clip for an automatic pencil, 5-ton trucks, factories, homes and churches. Millions of consumers are buying and using Sundberg-Ferar-designed automobiles, automatic coffee makers, refrigerators, stoves, and perfume atomizers. Sundberg-Ferar designed the cabinet for UNIVAC, the Remington-Rand computer that predicted the outcome of the 1956 Presidential election. People type on Sundberg-Ferar-designed typewriters, dig holes with draglines they developed, guide boats and airplanes with their navigational equipment, enjoy coffee and soft drinks from Sundberg-Ferar-designed dispensers.

As designers of consumer products (including most of Sears Roebuck's appliance line), Sundberg-Ferar may be the target of criticism from a current school that decries "change for the sake of change." To this observation, Sundberg-Ferar has a response: "Newness is not vulgar, despite what some critics say. Honest newness—and the improvements that go with it—is what is needed. A product can be beneficial and honest to itself—and be









new at the same time. We've got to change and improve to stay alive. In this country it is far more dangerous to be too conservative in your design than to be too advanced," says Montgomery Ferar.

How advanced are Sundberg and Ferar? Consider Monte Ferar's views on the kitchens of tomorrow: "Kitchens have come a long way since the wood-burning stoves of Grandma's day. We've gone from the ornate, to the round, to the current architectural square look. Does design history repeat itself? Not in this case. The squared-off architectural look will be with us as long as we have kitchens. As space becomes more valuable, kitchens will become smaller and we'll have to design to use all the vertical space."

As for appliances, Sundberg predicts a trend to "portable built-ins" designed to be free-standing with a built-in look. Says Ferar: "More and more, Americans are becoming mobile. We want to design our appliances so they will look built-in no matter how many times they're moved."

Ferar also sees refrigerators that will be roomier inside but no larger outside. All major appliances will be matched. "We want women to choose their appliances the same way they now choose their silver," says Ferar.

How do materials fit into the Sundberg-Ferar concept of "newness"? Few materials are newer than today's steels, and no materials are as versatile, as functional and as long-accepted as steel. It's not surprising that Carl Sundberg and Monte Ferar use a lot of steel. "A designer must know material—what it is, what it will do," says Carl Sundberg. "He keeps up with new developments. Materials are his clay. He must have empathy with them." About 90 percent of the products Sundberg-Ferar designs use steel because it is usually the material that is functionally suited for the job. Like most designers, they have found steel the most economical, strongest, and most versatile of the materials they use. In an average year, some 500,000 tons of steel go into Sundberg-Ferar-designed products, a far, far cry from the early days of the better mousetrap. USS is a registered trademark.



What's new in USS Design Steels

United States Steel demonstrates new alloy for cryogenic service: (USS) 9% Nickel Steel

CHEMICAL COMPOSITION

ASTM A-353 Grade	С	Mn	Р	s	Si	Ni
A	.13 max.	.80 max.	.035 max.	.040 max.	.15/.30	8.50/9.50
В	.13 max.	.90 max.	.035 max.	.040 max.	.15/.30	8.50/9.50

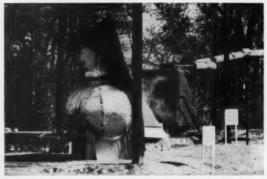
DESIGN DATA

ASTM A-353 Grade	Tensile Strength psi, min.	Yield Point (0.2% offset) psi, min.	Elongation In 2 in. pct., min.	Allowable Design Stress ASME, psi, max.	Lowest Test Temp. °F. ASTM A-300
Α	90,000	60,000	22	22,500	-320
В	95,000	65,000	20	23,750	-320

USS 9% Nickel Steel was specifically developed for low-temperature storage vessels operating down to -320°F, the boiling point of liquid nitrogen. This new steel has interesting design and money-saving possibilities for a wide range of cryogenic uses.

Recent tests at U.S. Steel's Fairless Works demonstrated the many advantages of USS 9% Nickel Steel. Called "Operation Cryogenics" and conducted jointly by United States Steel, Chicago Bridge and Iron Company and the International Nickel Company, they showed the excellent low-temperature properties of the steel, and that stress-relieving after fabrication is not necessary for vessels of either quenched and tempered 9% Nickel Steel or doublenormalized and tempered 9% Nickel Steel. Pressure vessels were cooled to -320°F, then pressurized to bursting. The burst pressure for all vessels-stressrelieved or not-was at least four times the design pressure. One of the non-stress-relieved vessels did not burst until 2,300 psi. Other vessels of USS 9% Nickel Steel were refrigerated to -320°F and battered repeatedly by "headache balls" with impacts exceeding 80,000 foot-pounds. Results clearly showed that 9% Nickel Steel in the as-welded condition (not stress-relieved) can withstand impacts far beyond any which are likely to occur in service.

USS 9% Nickel Steel is the most economical material available for cryogenic storage down to -320°F which includes liquid ethylene, methane, oxygen, and nitrogen. Its initial cost is lower than either Type 304 Stainless or aluminum alloys of the 5000 series, and



Burst-test for cylindrical-pressure vessels fabricated from USS 9% Nickel Steel, cooled to —320°F, then pressurized to bursting. This one was quenched and tempered—not stress relieved.

its excellent strength properties permit savings from the design stage to the completion of the vessel. USS 9% Nickel Steel has a high modulus of elasticity, high design stress, a low transition temperature, good ductility, ease of fabrication, good weldability and corrosion resistance. It is available in a variety of sizes and shapes: plate, tubing, bars, forgings, piping, sheets and structurals. It can be sheared, gascut, cold formed, forged, machined, drilled, punched, hot formed and welded. It can be furnished double normalized (NN), double normalized and tempered (NNT), quenched and tempered (QT), or in the asrolled condition for subsequent heat treating by the fabricator.

With the trend toward storage and shipment of gas in liquid form, the demand is growing for cryogenic metals that can be fabricated into land and sea-going storage vessels, tanks, intermediate containers, piping and accessory equipment.

The success of the full-scale test program "Operation Cryogenics" is speeding the revision of low temperature codes and specifications to permit the use of quenched and tempered 9% Nickel Steel vessels without post-fabrication stress-relieving. USS 9% Nickel Steel—already more economical in the present double normalized and tempered condition than competitive metals—becomes most economical in the quenched and tempered and non-stress-relieved condition. Detailed information is available from United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.





(USS) Ex-Ten: new high strength low-cost steel

USS Ex-Ten Steels are sold to minimum mechanical properties shown in this table. Typical chemical compositions are shown for information only.

MECHANICAL PROPERTIES

	EX-TEN 45 Plates, Bars, Structurals, Bar Shapes to ¾" incl. HR Sheets & Strip, CR Sheets	EX-TEN 50 Plates, Bars, Structurals, Bar Shapes to ¾" Incl. HR Sheets & Strip, CR Sheets	EX-TEN 55 HR Sheets & Strip
Yield Point, psi Min.	45,000	50,000	55,000
Tensile Strength, psi Min.	60,000	65,000	70,000
Elongation, Min. Sheets & Strip % in 2" Plates & Bars % in 8"	25 19	22 18	20
Cold Bend (specimen bend) Sheets & Strip Plates & Bars	Flat D-1T	D-1T D-1T	D-1½T

When hot rolled products are ordered annealed or normalized, the mechanical property requirements do not apply.

ASTM Standard Specimens; minimum number of tests and ductility modifications apply.

The newest member of the USS family of 10,000 steels is USS Ex-Ten, a high strength steel with a low initial cost that has major attributes of high strength steels and is ideal for "general range" applications requiring corrosion resistance equal to that of carbon steel.

This new steel is intended to fill the need for an economical grade where greater strength and weight reduction are the primary requirements. Suggested uses: automobile and truck parts, cargo containers, tote boxes, formed building members and many others. It has good ductility and weldability and is available in hot and cold rolled sheets and hot rolled strip, and in plates, bars, structurals, and bar shapes to a maximum thickness of 3/8 inch.

Plates and bars come in two yield strengths: Ex-Ten 50,000 and Ex-Ten 45,000 psi. Hot rolled sheets are available in 55,000, 50,000 and 45,000 psi; cold rolled sheets in 45,000 psi.

USS Ex-Ten has one of the highest strength-tocost ratios of all steels. Further information is available from United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

(USS) Tenelon: new non-magnetic Stainless Steel for great strength and weight reduction

USS TENELON is a completely austenitic nickel-free steel that has almost twice the yield strength of the 18-8 grades of Stainless. This enables the designer to work to higher design stresses, cut deadweight and still keep the many advantages of Stainless Steel: strength, corrosion resistance, excellent heat properties and formability.

Annealed USS TENELON has higher mechanical properties than any of the conventional austenitic Stainless Steels. At only 5% reduction, TENELON has a tensile strength equal to Type 301 Stainless at 18% reduction. At elevated temperatures, Tenelon is superior to 18 Cr-SNi Stainless and is about equal to 18-8 Cb and 18-8 Mo. Charpy V Notch impact strength is 220 ft. lbs. (no break) at 78° and 52 at

The corrosion resistance of USS TENELON has been tested in rural, industrial and marine atmospheres. In rural and industrial atmospheres it is comparable to Type 301 Stainless. In marine atmospheres, it is comparable to Type 430 Stainless. Tests have also been made in chemical plants, oil fields, dairies and even with anti-freeze, and show that TENELON's corrosion resistance is equal to other Stainless Steels for those applications-and TeneLon is less expensive and has almost twice the strength of most con-



ventional Stainless Steels. In mild acids, its corrosion resistance is about equal to Types 301, 302 and 201; in stronger acids, its resistance is equal to or better than Type 430.

Some suggested uses of USS TENELON: covered hopper cars (see illustration), passenger cars, automotive vans, tank trailers, fertilizer tanks, hightensile non-magnetic cables.

Detailed information is available on this new Stainless Steel. For a new booklet, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. USS, Ex-Ten and Tenelon are registered trademarks



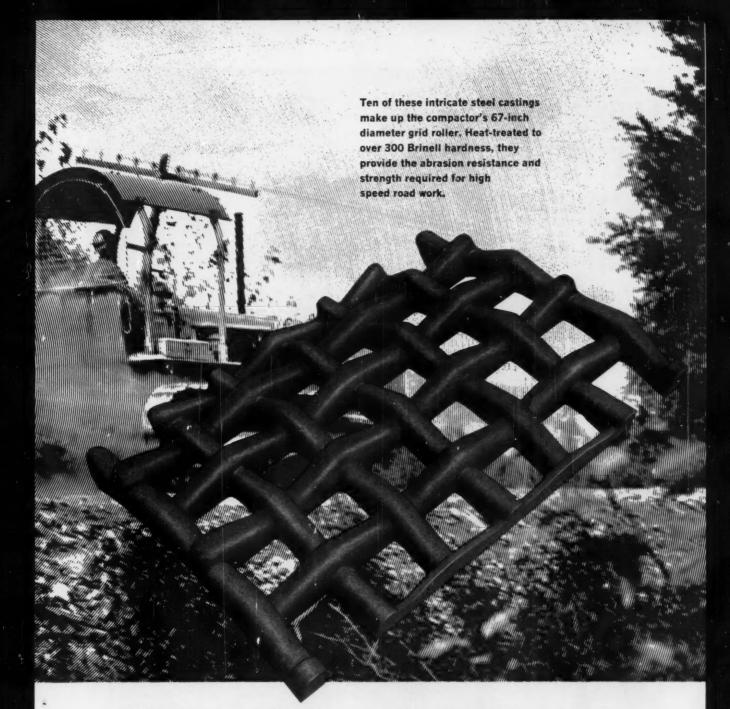


for metallurgical versatility

Only when you *cast* steel can you capitalize on the limitless possibilities of the world's most versatile metal. Steel castings can take jarring abuse and grinding abrasion. Searing heat and glacial cold. Thermal shock and corrosive attack.

Casting with steel offers the designer the sure path to follow in making components that withstand punishing service conditions. It is the most economical, most direct way of utilizing steel's inherent strength, toughness, dependability.

Consult your steel foundryman. Discover how you can obtain the steel you want, in the shape and exact alloy you need... with optimum economy, strength and design freedom.



metallurgical versatility plus

FUNCTIONAL DESIGN ... metal where you need it.

WIDE SELECTION OF PROPERTIES... for a variety of demanding applications.

BENEFICIAL GRAIN STRUCTURE...assures optimum multi-directional strength.

 $\label{eq:def:DIMENSIONAL UNIFORMITY...} \textbf{consistent duplication} \\ \textbf{of the part.}$

SHOCK RESISTANCE . . . for shock and impact resistance in compression, tension, torsion and shear.

SERVICE STABILITY...resists deflection and deformation of parts.

CAST-WELD & COMPOSITE FABRICATION...permits economical joining of single castings, or fabricating with other materials.

PROCESS FREEDOM . . . can be readily hot or cold pressed, brazed, plated, coated, and many other process operations.

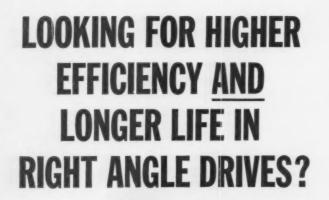
END-COST ECONOMY... steel castings are ideal when all cost factors and customer satisfaction are considered.

Advantages of steel castings and complete engineering information are detailed in the STEEL CASTINGS HANDBOOK. Send the coupon for information about this 680-page book.

NAME		
TITLE		
COMPANY		
STREET		
CITY	ZONE	STATE



STEEL FOUNDERS' SOCIETY OF AMERICA 606 TERMINAL TOWER . CLEVELAND 13, OHIO



Then take a closer look at Philadelphia Spiral Bevel Reducers. They'll give you an efficiency advantage of 5 to 50% over other types of right angle drives . . . depending upon ratios.

HIGH EFFICIENCY. With efficiencies of 95 to 98%, spiral bevel reducers will lower your power costs . . . reduce the cost of prime movers.

HEAVY DUTY. The bearings and shafting in Philadelphia Spiral Bevel Reducers are designed for 185% overload. Spiral Bevel Gears and Pinions are hardened after they are cut, then lapped to a mirror finish. Helical gearing in multiple reduction units is precision hobbed and shaved from through-hardened alloy steel. Result: greater load carrying capacity, longer life.

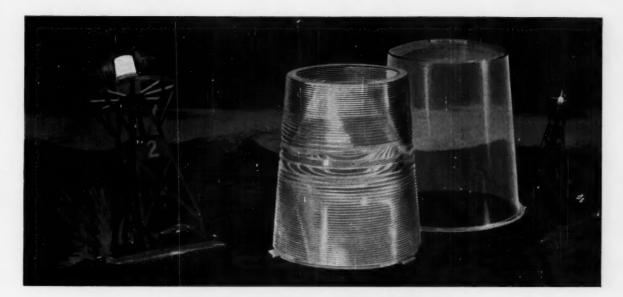
COOLER RUNNING. Compared to other types of right angle drives, Philadelphia Spiral Bevel Reducers run cooler. Separate cooling systems are not needed for most applications.

COMPLETE LINE. Philadelphia Gear offers the most comprehensive line of Spiral Bevel Reducers available — or we can build specially engineered units to meet any special requirement. Ratios from

1:1 to 238:1. Single, double or triple reductions in either vertical or horizontal types. Catalog SB-60 gives full selection data. Write on your company letterhead for your copy.

philadelphia gear drives

PHILADELPHIA GEAR CORPORATION King of Prussia (Suburban Philadelphia), Pennsylvania



Handsome and Hardworking Plexiglas...Implex



Flashing lights at sea shine brightly through large lenses and covers molded of PLEXIGLAS® acrylic plastic. The PLEXIGLAS parts are used in navigation lights for the U.S. Coast Guard, at a fraction of the cost and weight of cut glass lenses. Precision molding of the lens pattern gives the PLEXIGLAS lens maximum efficiency in light control, and the material resists weather, breakage and salt water.

Winking lights at home are revolutionizing indoor photography by making indoor pictures without flashbulbs possible, with the new wink-light attachment shown above. Tough IMPLEX®, the high impact acrylic, gives handsome appearance and rugged durability to the housing. PLEXIGLAS is used for the lens.

We will be glad to help you use these Rohm & Haas acrylic molding materials—to your advantage.

ROHM HA[®]AS

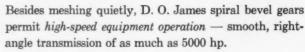


In Canada: Rohm & Haas Company of Canada, Ltd., West Hill, Ontario.





Quiet...very quiet spiral bevel gears with 98% efficiency



Multiple-tooth contact with an efficiency range of 95 to 98% decreases power consumption — increases load capacity. Sizes: 1'' to 30'' diameter, 24 to $1\frac{1}{2}$ DP.

For details on a *complete selection* of cut gears, speed reducers, flexible couplings and gear motors, contact your D. O. James representative or write, outlining your requirements.

D. O. JAMES GEAR MANUFACTURING CO. 1140 West Monroe Street, Chicago 7, Illinois Since 1888, every type of cut gear and gear reducer 161







.. where you always get good gearing





RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities
by Fred E. Graves

Avoiding Bolt Failure Under Dynamic Loads

Dynamic loading in a tightened bolt may vary from no stress at all to that exceeding the bolt preload.

A classic example of dynamic loading is a connecting rod in a reciprocating engine. But you encounter such cyclic stress wherever you have fastened members that move or vibrate.

It has been shown that when the fluctuating stress approaches or exceeds actual bolt tension early fatigue failure can be expected.

DEMONSTRATION

In tests, bolts tightened to a 1420 pound tension and stressed cyclically to 9215 pounds, failed after only 5960 cycles. Identical bolts tightened to 8420 pounds, and cyclically stressed to the same 9215 pounds, went 4.65 million cycles before failing.

Had the bolts been tightened to beyond the 9215 pounds, it would have been impractical to try to cycle them to failure.

So, if you want to avoid fatigue failure, be sure bolt tension exceeds the maximum dynamic load, known or estimated. This way, the bolt's life under dynamic loading will approach its life under static loading.

Take advantage of the high residual tension available to you in today's high strength bolts and screws, and thereby avoid fastener failures.

Why Tensilock®screws make ideal fasteners for "double-duty" jobs



TENSILOCK screws are engineered to prevent both slippage and loosening.

Heat-treated, they are so strong—even stronger in ultimate tensile strength than high-strength hex screws—that they can keep fastened members from slipping by high clamping force. As an added benefit, this permits more liberal tolerance in metalworking operations. Holes in fastened members can be oversize, slotted, eccentric, misaligned.

LOCKED-IN PLACE

Once they're tightened down, Tensilock screws can't shake or vibrate loose under reasonable service conditions. Sharp, angular, carburized teeth beneath their heads bite in to resist counter-clockwise loosening tendencies. To back off, 25% more off-torque is required than on-torque.

SAVES PARTS, TOO

Tensilock screws combine an integral washer with their self-locking feature for a unique one-piece fastener that speeds assembly.

Moreover, with their higher clamping force, it's possible that three Tensilock screws will do the job as well, or better, than four Grade 2 fasteners.

To take advantage of them, we suggest you call in an RB&W technical advisor. Or, write for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif, Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Now-Finishes Add Beauty to Tough Malleable Castings

Beautiful, protective finishes on tough Malleable iron castings will give your products a superior combination of appearance, ruggedness, and economy. Get complete information on this sales-getting combination from any of the progressive companies that display this symbol —



New Ideas for your products are suggested in Data Unit No. 115, available free from any member of the Malleable Castings Council, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.



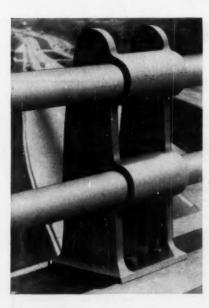
The castings shown have been painted, blued, chromium and cadmium plated, plastic coated, porcelain enameled, galvanized, and machined.

When appearance and long service life are important to your products, Malleable castings offer many advantages. Painting, hot dip galvanizing, blueing, and electroplating have long been used with Malleable castings because of their economy, attractiveness, and resistance to a variety of destructive conditions.

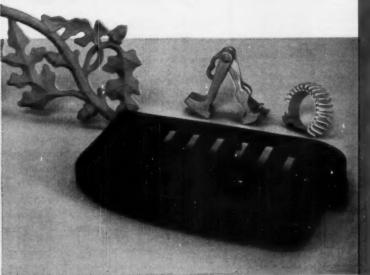
Several exciting new finishes appear very promising and are currently being tested by Malleable producers. Vinyl plastic in thin, contour-hugging films or thick, resilient coatings provide exceptional chemical resistance, and are available in a wide spectrum of strikingly beautiful colors.

Another attractive finish is porcelain enamel. In addition to smooth, gleaming surfaces in unlimited colors, it has excellent resistance to heat and chemicals.

The variety of finishes which can be successfully applied to Malleable gives designers outstanding opportunities to combine decorative and protective surfaces with the rugged dependability, economy, and versatility of Malleable castings. Call your Malleable supplier for information and quotations.



Bridge railing posts on the Connecticut Thruway are Malleable castings for three important reasons: (1) strong, ductile Malleable offers far greater resistance to fracture upon collision than other materials tried, (2) Malleable is easily galvanized for additional salt air corrosion resistance, and (3) with thousands of these posts in use, Malleable's economy produced real savings.



For Quality and Economy Use

MALLEABLE

For Service Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Alloy Foundries Division, The Eastern Co., Naugatuck

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Castings Co., Cicero 50
Peoria Malleable Castings Co.

INDIANA
Albion Malleable Iron Company,
Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Castings Co., Indianapolis 22

Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS

Beicher Malleable Iron Co., Easton

IOWA

MICHICAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Futy Div. Com. Motors Saginar

Cadillac Malleable Iron Co., Cadillac Central Fdry. Div., Gen. Motors, Saginaw MINNESOTA Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division
The Eastern Co., Sofvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

CHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
National Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

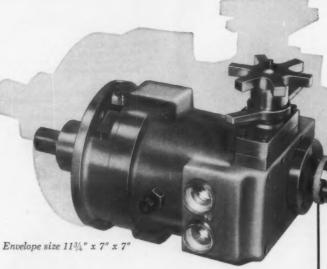
TEXAS
Texas Foundries, Inc., Lufkin
WEST VIRGINIA
West Virginia Mall, Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

These companies are members of the Malleable Castings Council

Light-weight, compact and extremely versatile - the reliable

IP Z5U INUUS HYDRAULIC PI



One of the complete new range of quality built

hydraulic pumps and motors by Lucas-Rotax,

the IP 250 offers many technical advances and

advantages. • Small size • Low weight • Variable

volume * Low noise level at higher operating speeds

• Low cost • High efficiency • Fitted with integral or

remote pressure compensator as standard equipment.

For further information, contact the agent or

office nearest you today, or write for technical

LUCAS-ROTAX

PUMP DETAIL

Basic Pump Fixed Stroke

Nominal Rating at 3,600 r.p.m... 18 G.P.M.

Displacement (cub. ins./rev.)... 1.157

5000 Working pressure up to...... 3000 (lbs./sq. in.) (continuous)....

Speed up to...... 4000

(r.p.m.) (continuous)......

Input h.p. at 1,000 r.p.m. and 1,000 lb. per sq. in. differential 3.32

Weight..... 29 lbs. Operating Temperature, ... °F - 40 to 200

Direction of Rotation..... Either

Pressure Compensator Range...500-5000 p.s.i.

a product of creative engineering by

LUCAS CAS-RO

WITH OFFICES AND SERVICE DEPOTS THROUGHOUT NORTH AMERICA

BOSTON . NEW YORK . CHICAGO . LOS ANGELES . HOUSTON . SAN FRANCISCO . CLEVELAND JACKSONVILLE . DENVER . SEATTLE . BALTIMORE . TORONTO . MONTREAL . VANCOUVER

literature.



For the book cover and record album, gameboard, box, and table top, there's a specially made paperboard by Continental Can Company. Whatever you design, make, fashion or fabricate-paperboard probably belongs. And, Continental Can Company offers the widest variety of paperboard-for the widest variety of uses-available anywhere. For service and quality, for every paperboard need, contact Continental Can Company...You can't buy better.

To learn more about the use of paperboard in all phases of industry, send coupon to: Paperboard and Kraft Paper Division, Continental Can Company, 633 Third Avenue, New York 17, N. Y.

by CONTINENTAL CAN

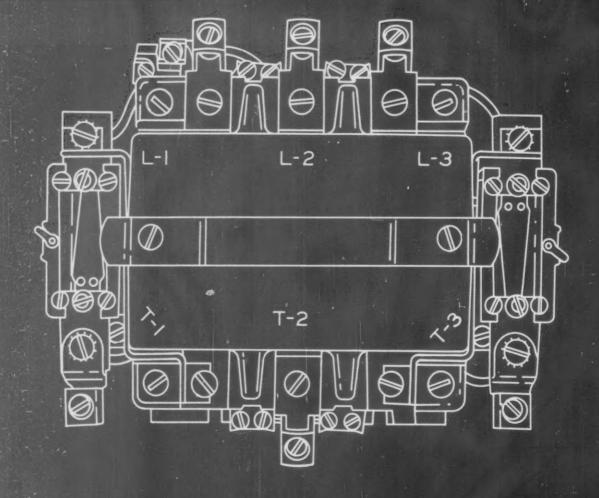
PAPERBOARD. ... the best material for so many uses!

SEND COUPON TODAY!

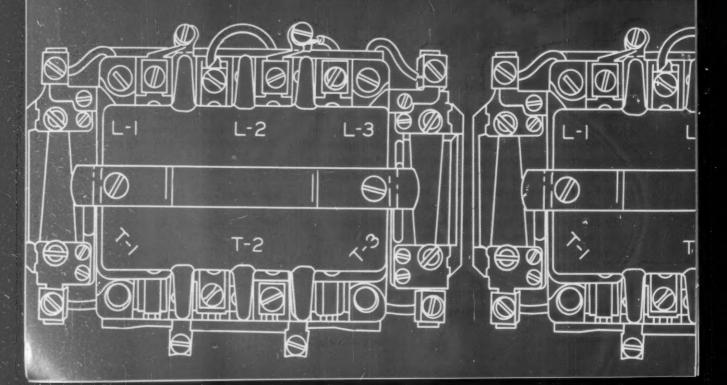
I would like further information on the use of paperboard. No obligation, of course.

Organization.

PAPERBOARD & KRAFT PAPER DIVISION / CONTINENTAL @ CAN COMPANY, 633 THIRD AVENUE, NEW YORK 17, N. Y.



Note that TWO NEMA Size 2 and THREE NEMA Size 1 ARROW-HART "RA" Starters Fit on





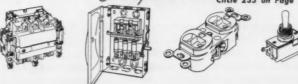
these pages with room to spare!



Space-thrifty starters are not new... at Arrow-Hart! We've made this design for over 10 years. This means you buy 10 years' field-proven experience with each starter. Nobody else can offer you that. And nobody else can offer you an *AMBIENT COMPENSATED OVERLOAD RELAY that Automatically compensates for cold or heat from —20°F to +165°F. For the whole compact story, Nema sizes 00 through 5, write for Form A-262-R to The Arrow-Hart & Hegeman Electric Company, Dept. MD, 103 Hawthorn Street, Hartford 6, Connecticut.



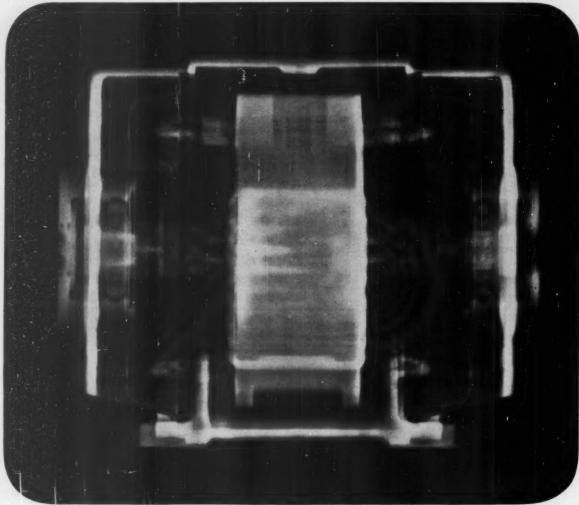
Quality since 1890 Circle 235 on Page 19



MOTOR CONTROLS . ENCLOSED SWITCHES . WIRING DEVICES . APPLIANCE SWITCHES

ALLIS-CHALMERS





Actual radiograph of a 5-hp open-type motor taken with a 24-million volt Allis-Chalmers Betatron.

X-ray view of motor health

Invisible standards of perfection increase life expectancy of every Allis-Chalmers motor

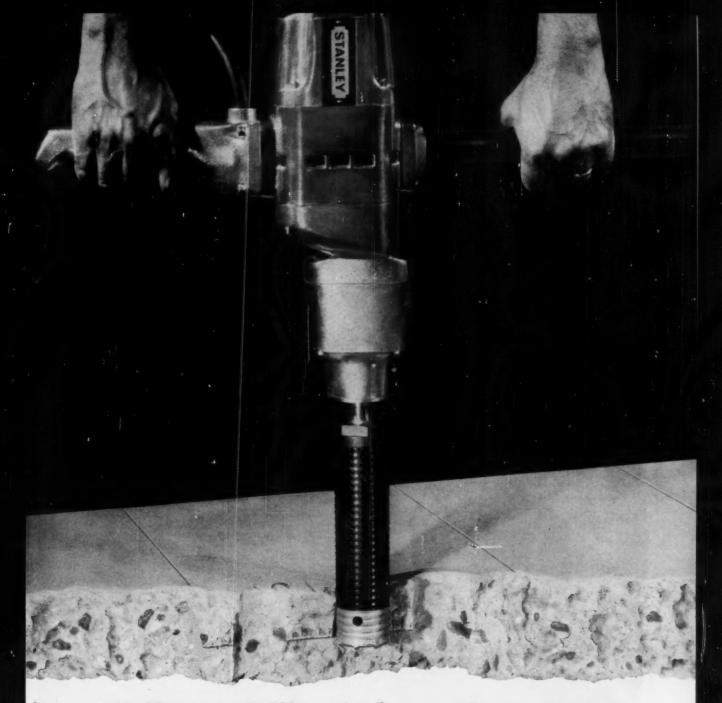
The exceptionally long performance of A-C open motors proves the value of thinking beyond established standards of design . . . of taking "significant new achievement" as the ideal.

This ideal led to many refinements for A-C open motors: doubleshielded bearings that keep dirt out and allow controlled migration of grease, permanently numbered leads for easy identification and connection, and heavy-duty cast iron frames that resist corrosion and keep rotating parts perfectly aligned.

For totally-enclosed, open-type and Super-Seal general purpose motors, and electrically or mechanically modified definite-purpose motors, choose the motor built to invisible standards of perfection. Choose A-C. Special application help available.

Call your nearby A-C representative. Or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis. Super-Seal is an Allis-Chalmers trademark.





Built to drill reinforced concrete

Stanley No. 404 portable drill gets critical strength from gears and pinions of Nickel alloy steel.

This electrically powered impact drill is designed to cut through reinforced concrete, brick, stone, masonry materials, and concrete pipe ... without deflection. It can drill holes or cut cores in any diameter from $\frac{3}{16}$ " to 4" without chipping, cracking or breaking out when close to an edge.

To give this hard-hitting drill built-in stamina, Stanley engineers specify carburized AISI 4620 (1.8% nickel) for critical parts of the power train. The hard case and tough core of this nickel alloy steel stand up to the severe

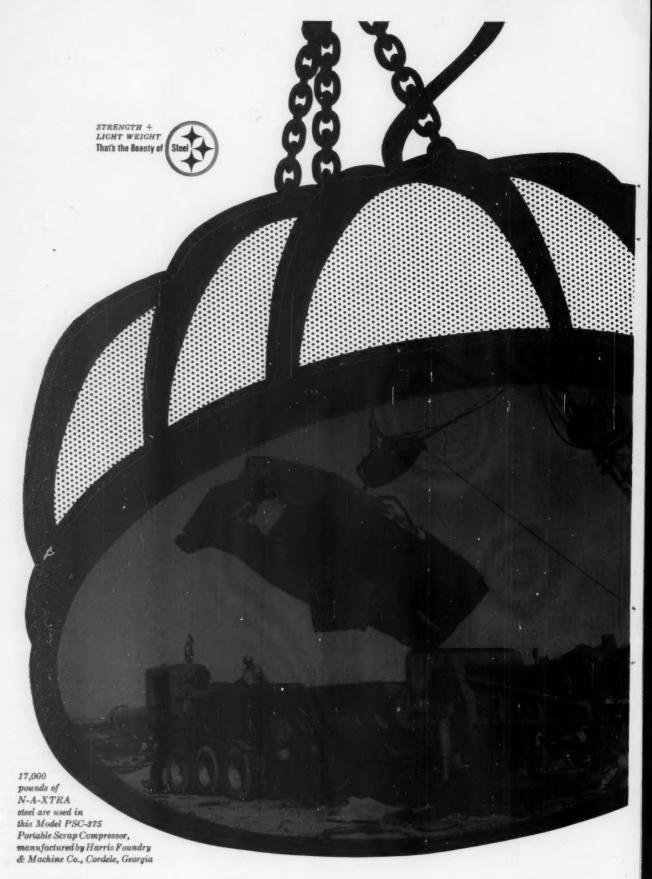
operating shocks of impact drilling ... provide outstanding resistance to fatigue and wear.

When you design, order, or use heavily stressed machine components, remember that nickel alloy steels take the tough jobs in stride. For helpful engineering data on these alloys write to Inco. We'll be glad to help.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street, New York 5, N. Y.



stand up to the severe Nickel makes alloys perform better longer
Please direct inquiries to advertiser, mentioning MACHINE DESIGN



STRENGTH + LIGHT WEIGHT OF

N-A-XTRA

HIGH-STRENGTH STEEL SOLVES PORTABLE SCRAP COMPRESSOR PROBLEM

This unique portable scrap compressor can squeeze an entire auto body into a 21" x 36" x 24" bale of 20% dense steel scrap, using a ram pressure of 375 tons. Designed to be hauled from job to job by a conventional truck-tractor, it goes to work in outlying wrecking yards, compressing bulky scrap into marketable bales that can be shipped economically.

Because it must be moved over the highway and meet established load limits, a pressing problem in designing the PSC-375 was weight. Mild carbon steel with the required strength would weigh too much. N-A-XTRA high-strength steel solved the problem. It fully met all strength and fabrication requirements, yet kept total unit weight within acceptable limits for portability.

Portability may not be the controlling factor in your product—but the same steel that solved this problem is the one to remember when only the strongest steel will do. Pound for pound, N-A-XTRA steels are nearly three times stronger than mild carbon steel. Rugged conditions, heavy loads and weight-saving construction—in such applications, for example, as heavy machinery and pressure vessels—are challenges that N-A-XTRA is designed to meet.

With excellent weldability, formability, and toughness even at subnormal temperatures, N-A-XTRA low carbon, extra strength alloy steels give superior results with conventional fabricating methods, including cold forming, gas cutting, shearing and machining. N-A-XTRA high-strength steels are available in four levels of minimum yield strength, from 80,000 to 110,000 psi, and in sizes ranging from ½8" to 1" thick, up to 72" wide and up to 35' long. For further information, write Product Development, Dept. MD-12, Great Lakes Steel Corp., Detroit 29, Michigan.

DESIGN NOTE: Model PSC-375, Portable Scrap Compressor, uses N-A-XTRA 100 (minimum yield strength, 100,000 psi) in engine and tank mounts, bed and side ribbing, arm housings and end housing. Sizes—¼", ¾". ¾" and 1" thick. Fabrication followed standard gas cutting and welding procedures.





a product of

GREAT LAKES STEEL

Detroit 29, Michigan

N-A-XTRA STEELS ARE AVAILABLE AT THESE STEEL SERVICE CENTERS

Benedict-Miller, Inc. Lyndhurst, New Jersey

Interstate Steel Co.
Des Plaines, Illinois

O'Neal Steel, Inc. Birmingham, Alabama Joseph Demsey Co. Cleveland, Ohio

Lockhart Iron & Steel Co. Pittsburgh, Pennsylvania

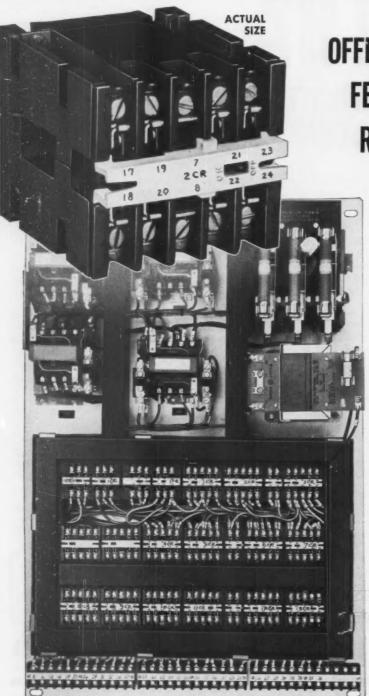
Salt Lake Hardware Co. Salt Lake City, Utah Ducommun Metals & Supply Co. Los Angeles, California

Marsh Steel & Aluminum Co. Kansas City, Missouri

A. C. Leslie & Company, Ltd. Montreal, Canada

Great Lakes Steel is a Division of NATIONAL STEEL CORPORATION

NEW General Electric 10-amp,



SNAP-IN TROUGH COVER between top and middle rows of relays (on lower half of panel above) has been removed to show how relay sides form own wiring trough. Space-consuming wiring trough is eliminated, and relays can be mounted closer together.

OFFERS 4 SIGNIFICANT FEATURES NO OTHER RELAY CAN MATCH!

1. ONLY 300-VOLT RELAY WITH CONVERTIBLE CONTACTS

You can change contacts from normally open to normally closed in 90 seconds . . . with only a screwdriver. Coils too, can be changed in seconds . . . and you can make up any form you need through 8 poles from basic 4-pole relay. Result: increased flexibility, reduced inventory costs.

2. ONLY 300-VOLT RELAY TO FORM ITS OWN WIRING TROUGH

New CR120 relays eliminate need for separate wiring trough—require only 5% square inches of mounting area. Result: panel size is substantially reduced because you can mount more relays in a given space.

3. ONLY 300-VOLT RELAY WITH ALL TERMINALS OUT-IN-FRONT

There's no double-decking of terminals to complicate hook-up. Wiring and maintenance are simple because all terminals are out-infront where they are most accessible. Result: important savings in installation and maintenance time and costs.

4. ONLY 300-VOLT RELAY OFFERING ALL THESE FORMS

Choose from standard 2-, 4-, 6-, and 8-pole relays and latched and pneumatic timer forms. Also available are 2-pole adder kits, allowing you to assemble 6- and 8-pole relays from basic 4-pole form.

Your General Electric sales engineer has a sample of this new 300-volt relay. Call him today for a demonstration. Or, write for publication GEA-7329, General Electric Co., Section 811-26, Schenectady 5, New York.

Progress Is Our Most Important Product

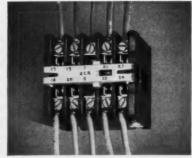
GENERAL & ELECTRIC

300-volt industrial relay....

Save Panel Space, Installation Time With These Design Features



90-SECOND CONTACT CHANGE-Convertible contacts may be changed from normally open to normally closed with only a screwdriver . . . in the field. Allows you circuit flexibility, reduces your relay inventory.



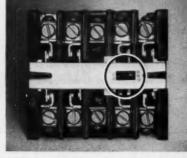
ALL TERMINALS IN FRONT-Have terminalboard accessibility-no need for doubledecking . . . even on 8-pole forms. Result: complete accessibility from the front means installation time is greatly reduced.



HANDY WRITE-ON MARKING STRIP-White nylon marking strip lets you label each relay and all wires. Result: visual identification of relay and wire numbers saves time when inspecting or trouble shooting.



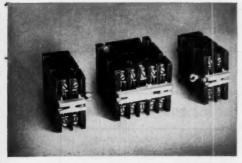
WIDELY-SPACED TERMINAL BARRIERS-Plenty of space between terminal barriers (3/8 inch) allows you easy access with standard screwdriver for connecting leads. Large pan-head screws add to ease of hookup.



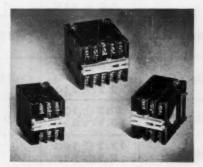
VISIBLE CONTACTS-All contacts are visible at a glance. You can check panel functions manually by moving indicating tab. ON-OFF identification on marking strip indicates whether or not coil is energized.



30-SECOND COIL CHANGE-Inspect or replace coil by loosening two screws and pulling out coil. Can be done without the use of special tools . . . and without removing the relay from the panel.



BUILDING BLOCK POLE-ADDERS-Two-pole adders can be mounted on sides of basic relay to give 6- or 8-pole device. Allows you building-block flexibility . . . in the field. All forms also available from factory.



COMPATIBLE DESIGN FOR ALL FORMS-Same design used for latched relays, relays and timer (1 to r). Height, wiring arrangement, and terminal locations are alike for all forms. Result: simplified installation.



HIGH CONTACT FIDELITY-Self-cleaning contacts have unique "scrubbing" action. Movable contact springs are mounted at an angle so contacts slide over each other to wipe

GENERAL



From Monsanto FluiDesign Service...

NEW "BLOOD" FOR ELECTRONIC

Coolants for computers . . . designed inside the circuit!

Pinpointed heat control will be more critical than ever in tomorrow's big computers—to assure *reliability* for the new jobs they'll be called upon to perform. Today, an "air conditioned" room, or perhaps forced-air cooling, keeps temperature of circuits within bounds. But tomorrow's transistorized, unattended computers will service oil refining, chemical processing, production lines, radar interpretation—in environments from scorching desert to arctic blizzard. Safe-

guard these "big job" circuits with packaged fluid dielectric/coolants—instead of bulky convection cooling or cumbersome forced-air systems. Precise heat control with fluids can make your equipment more reliable—more salable—can help qualify electronic equipment for many new tasks.

MONSANTO FLUIDESIGN SERVICE OFFERS YOU:

- 1. Sophisticated application experience with fluids
- 2. Years-ahead research on new types of fluids
- 3. Time-saving facilities for testing new uses
- 4. More job-proven functional fluids than any other manufacturer in the world
- Design-oriented know-how to help you develop more compact, safer, and more reliable equipment



MONOISOPROPYL BIPHENYL*	-40 to 650	75 @ 0 4.6 @ 100 1.42 @ 210	-65	650	315	
05-80		(Preservative Fluid—non-operational				
AROCLOR® 1242	+40 to 600	17.2 @ 100 2.5 @ 210	+2	600	fire resistant	
05-124*	+40 to 900	363 @ 100 13.1 @ 210	+40	800	550	
OS-59	-65 to 600	1380 @ -65 6.8 @ 100 2.2 @ 210	<-85	500	370	
COOLANOL 45	<-85 to>400	2400 @ -65 12.2 @ 100 3.95 @ 210	<-85	400	370	
COOLANOL® 35	<-120 to >350	934 @ -65 6.5 @ 100 2.2 @ 210	<-120	350	370	
TYPICAL PROPERTIES OF A FEW MONSANTO FLUIDS	OPERATING TEMPERATURE RANGE (°F)	VISCOSITY (Centistokes @ °F)	POUR POINT (°F)	MAXIMUM LONG TERM BULK TEMPERATURE (°F)	FLASH POINT (°F)	

*RADIATION RESISTANT

THESE COOLANTS ARE AVAILABLE NOW AND MANY OTHERS

BRAINS AND RADAR EYES

Heat control to defy the arctic or tropics!

If you are designing radar "eyes" to operate intelligence networks ranging from the frigid top of the world to the steaming tropics, you'll want to check with Monsanto about coolant fluids that operate reliably from below minus 80° F. to over 500° F. These fluids are chemically stable; won't freeze or sludge; do not corrode circulating pumps or the vital "veins" of high-power klystrons, magnetrons, traveling

wave, or tropospheric scatter installations. Do you want the maximum reliability of pinpoint temperature control—with a minimum of mechanical and maintenance problems with the coolant? Monsanto fluids can help you reduce system complexity—while increasing system reliability.



BE SURE TO GET YOUR FACT-PACKED FLUIDESIGN FILE. WRITE ON YOUR LETTERHEAD TO:



Monsanto Chemical Company Organic Chemicals Division FluiDesign Service, Dept. 4452A St. Louis 66, Missouri

FIRE POINT (°F)	COEFFICIENT OF THERMAL EXPANSION (per °F)	SPECIFIC GRAVITY @ 25°/25°C or M. Pt.	SPECIFIC HEAT @ 25°C or M. Pt. BTU/lb/°F	THERMAL CONDUCTIVITY BTU/hr/ft²/ft/°f	
430	0.00047	0.89	0.45	0.079	
430	0.00048	0.89	0.45	0.080	
435	0.00046	0.88	0.45	0.077	
660	0.00033	1.204	0.365	0.075	
does not support combustion	0.00038	1.38	0.29	0.058	
product-prot	ects systems in sto	rage)			
340	0.00045	1.00	0.40	0.070	

ARE UNDER DEVELOPMENT FROM NEW BASE STOCKS

"We had 18-20 hours downtime every time we changed heats. With strip, we just hook on from heat to heat. No downtime."

"With strip we use smaller blanks to produce the same part."

"By using strip we save downtime, die repairs."

"Rejects have dropped from about 8% to less than 1%."

"We found we couldn't afford the low cost of sheet."



Read why Target Stamped Products, Inc., Kinsman, Ohio, switched from strip to sheet—and then back to strip. Comments are Harvey Haynam's, Target's president:

"We thought we'd give sheet a try back in 1958. The low cost looked too good to pass up. Today, you'd have a hard time finding a piece of cold rolled sheet around the shop.

"We were absorbing 18-20 hours of downtime every time we changed heats. With strip, we just hook on from heat to heat. The characteristics are the same from heat to heat and coil to coil. We don't waste time adjusting our dies.

"Strip saves us metal. We can use smaller blanks to produce the same part. I'd say we save from $\frac{1}{6}$ " to $\frac{3}{2}$ " of metal per part. That's a lot of steel when you're turning out 25-30 million parts a year.

"We don't have gauge problems now. The strip we buy is always rolled within our working tolerance. We work to a plus or minus .0025 inches.

"So far, strip hasn't given us lamination troubles. It doesn't take much lamination to give you big trouble in a deep drawing operation. When the metal separates, part may stick to the punch while part stays in the cavity. As another blank transfers to the same station, there's a double smash and the die is ruined. That hasn't happened with strip. Saves a lot of downtime and die repair.

"Strip takes a deep draw without thinning out on you. Its uniform temper pays off when you're turning out Silent Blocks where both the ID and OD have to be right or the part's a reject.

"All in all our rejects have dropped from about 8% to less than 1% since we switched back to strip.



Outer metal bushing of a Silent Block. Target Stamped Products turns out millions of these each year for the auto industry. Silent Blocks are used in the suspension systems of all American cars—about eight to a car. To produce the piece, Target must work to a plus or minus .0025" tolerance or the Silent Block won't work. When Target switched back to strip, their rejects dropped from about 8% to less than 1%.



"You can have all the automation in the world, but if you're using the wrong steel, it just nickels and dimes you to death. With strip our machines keep working; we need less supervision, less tool repair. Our trim is small and our percentage of rejects is the smallest we've ever known. We found out we couldn't afford the low cost of sheet. That's why we're back with strip."

The switch is back to strip

Cold rolled sheet steel can be your best buy on a cost per pound basis. Certainly its quality has risen sharply since the war. But, pound cost is only part of the story. If you really need steel tailored to your specific production requirements, cold rolled strip is the answer.

Strip is not sold on an as-rolled basis. What you buy is a specific chemistry, temper, dimension, edge and finish to precisely meet your fabricating and end-use requirements.

American Steel and Wire has over 12,000 mill practices in available strip specifications. Many of your processing steps may actually be eliminated by using cold rolled strip.

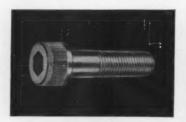
Take a hard look at your production line and let our salesmen look with you. Check your rejects, your downtime, your scrap rate. Perhaps you can improve the quality of your product and cut production costs at the same time, with *tailored-to-the-job* cold rolled strip from American Steel and Wire. American Steel and Wire Division, Rockefeller Building, Cleveland 13, Ohio. USS and American are registered trademarks



Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors Tennessee Coal and Iron Division, Fairfield, Ala., Southern Distributors United States Steel Export Company. New York, Distributors Abroad

Here's what UNBRAKO—and only UNBRAKO—now offers you in standard socket head cap screws

UNBRAKO pHd Hi-Life, today's only all-new socket screw. Increased bearing area, radiused thread root give up to 2½ times as much holding power, twice the fatigue strength of ordinary screws.





K 16 socket heads give you a bonus of 300% more fatigue life than regular socket screws; replace costly specials, provide design insurance in high fatigue applications.

Stainless Unbrakos meet your needs for corrosion-resistant fastening through a temperature range from -300° to 800°F. Other design considerations: low magnetic permeability; good appearance.





UNBRAKO KS 812 stainless socket screws offer 125,000 psi tensile—certified; help you increase strength of stainless assemblies without paying the price of specials. Identified by groove around socket.

Lately you have been reading about new developments in the design and performance of UNBRAKO socket head cap screws. For your reference, here is the complete story in one package:

UNBRAKO pHd* with Hi-Life Thread

The advanced tension fastener for the '60s. New pHd head with increased bearing area gives you up to 2½ times as much holding power, safeguards preload, defies loosening under vibration. Radiused root of new SPS Hi-Life thread form drastically reduces stress concentrations at point where 85% of screw failures occur. Result: Twice the fatigue life. Forged heads, rolled threads preserve grain flow, add further strength and fatigue resistance. Available with Nylok† self-locking feature if desired. Sizes #0 to 1½ in. in alloy steel . . . full range of plating and other finishes. Tensile strength: 160-200,000 psi.

Stainless UNBRAKO Socket Screws

Available in a variety of corrosion-resistant alloys . . . and with Nylok. Standard processing includes passivation surface treatment, which forms a protective film and removes contaminants. Silver plating and/or molybdenum disulfide can be added as a lubricant to prevent galling and reduce the thread friction sometimes encountered at elevated temperatures. Sizes #0 to % in. with forged pHd head and fully formed Hi-Life thread.

NEW HIGH-PERFORMANCE UNBRAKO K SERIES

UNBRAKO K 16—Endurance fasteners replace specials in high fatigue service. They give you twice the fatigue life of regular UNBRAKOS; four times that of ordinary socket heads—in a standard fastener, reasonably priced. Threads rolled, fillet under head cold worked—both after heat treat. Shank precision ground to insure no decarburization. Sizes #8 to ½ in. in 8740 A.Q. steel. pHd head, Hi-Life thread.

UNBRAKO KS 812—A stainless socket head cap offering a guaranteed tensile strength of 125,000 psi minimum. Yet this precision forged, burr-free fastener is a standard, available in quantity off the shelf. Made of high-grade austenitic stainless, hardened through cold working. Has pHd head for greater holding power; SPS Hi-Life thread for increased fatigue resistance. Magnetic permeability under 1.2. Serviceable from -300° to 800°F. Sizes #8 through 3/6 in.

Standard Unbrako socket head cap screws are available from stock through your industrial distributor. See him for more information or write Standard Pressed Steel Co. Industrial Fastener Division, SPS, Jenkintown 18, Pennsylvania.

*proper Head design (1960 Series) †T.M. Reg. U.S. Pat. Off., The Nylok Corporation



where reliability replaces probability

DESIGNER'S CHOICE

for temperature control the applicationoriented Fenwal "500" Series

A complete line of temperature controls

No two control problems are identical — but solution to any one is simplified by the broad line of Fenwal "500" Series controls. Whether you need an on-off control, or a multi-point proportioning indicator/controller, a standard, stock Fenwal "500" is best for you. We call them application-oriented. Why? Because they combine characteristics that meet and solve the problems most commonly encountered in designing any system requiring temperature control or indication — or control and indication. Here are some major problems and the positive Fenwal "500" answers.

Universal Mounting. "500's" mount in any posi-

tion — and controls and indicators function perfectly regardless of the position.

Vibration Resistance. You can shake and shock any "500" control — it's ruggedly built to withstand vibration and shock.

Fast Sensor Response. Thermistor sensing in all Fenwal "500" controls provides the fastest response to temperature variation. And all Fenwal "500" *Indicating Controls* are used with *matched thermistor* probes eliminating calibration.

Extreme Sensitivity. 0.1°F sensitivity — standard for all "500" controls — cannot be topped even by more expensive controls.



designed for use ... and abuse

Independent Control Circuit Design. Circuits for control and indication work independently — malfunctions of indication do not affect set point.

Dependability. All-transistor circuits take a beating, also run longer on less power than vacuum tubes. And all "500" units are built for easy servicing.

Precise Readability. "500" indicators are available in a choice of scale ranges from -50 to 1200° F for the accuracy you need in readings. Suppressed zero is standard (and expanded scales can be obtained at extra cost).

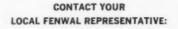
Economy. Fenwal "500" controls cost less per

unit than comparable controls and offer even greater savings in quantities.

Advanced Styling. The modern yet functional design of Fenwal "500" controls complements the advanced design of any system — and the distinctive techniques of its designer.

By contacting your Fenwal Sales Engineer in the early phases of a design you can get full details and the benefit of his experience in selecting the "500" unit that is compatible with your best design approach. For descriptive literature on any "500" control, write FENWAL INCORPORATED, 199 Pleasant Street, Ashland, Massachusetts.





ALBANY Tel: HObart 2-5364

ATLANTA Tel: TRinity 5-7244

BALTIMORE Tel: VAlley 5-4445

BLOOMFIELD (N. J.) Tel: EDison 8-6900

BUFFALO Tel: TR 6-3757 CHARLOTTE Tel: 847-1616

CHICAGO Tel: HArrison 7-5464

CINCINNATI Tel: TRinity 1-0605 & 1-0606

CLEARWATER (Fla.) Tel: CLearwater 3-7706

CLEVELAND Tel: PRospect 1-7112

COLUMBUS Tel: AMherst 7-8260

DALLAS Tel: EMerson 8-2325 DAVENPORT Tel: 6-5233

DENVER Tel: GLendale 5-3651 GEnesee 3-0821

DETROIT Tel: KEnwood 8-2100 ELgin 7-0677

FRAMINGHAM (Mass.) Tel: TRinity 2-3526

HOUSTON Tel: UNderwood 9-3306

INDIANAPOLIS Tel: MElrose 5-5313

KANSAS CITY (Mo.) Tel: SOuth 1-6545

Tel: FRanklin 4-8825

LOS ANGELES Tel: DUnkirk 8-3168

MILWAUKEE Tel: BRoadway 1-3021

MINNEAPOLIS Tel: FEderal 6-6631 NEW HAVEN Tel: ATwater 8-1638

NEW ORLEANS Tel: EVergreen 2392

NEW YORK CITY Tel: Worth 4-2990 PHILADELPHIA

Tel: GReenwood 3-4477
PITTSBURGH

(Wilkinsburg) Tel: FRemont 1-6220

ST. LOUIS Tel: CHestnut 1-2433

SAN FRANCISCO Tel: YUkon 2-3713

SEATTLE Tel: EAst 3-8545

SYRACUSE Tel: GRanite 1-3074 TULSA

Tel: TE 6-2501 MONTREAL, P.Q. Tel: WEllington 7-3521

TORONTO, Ontario

The application-oriented "500" controls are typical examples of how

Fenwal

CONTROLS TEMPERATURE... PRECISELY

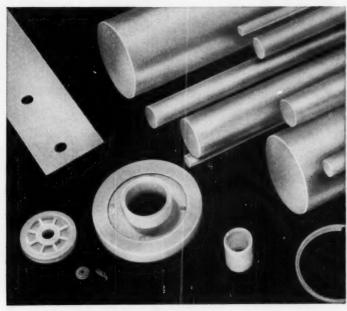
Fenwai Incorporated • Ashland, Mass.





DELRIN

In Design Engineering



For ready cutting and machining, Style 8701 Delrin rod is available in standard diameters $1.1/4^{\prime\prime}$ to $3^{\prime\prime}$ standard lengths 4 and 8 feet.

NEW GARLOCK DELRIN now ready to help you achieve the extraordinary in product design.

This remarkable new material opens new horizons to you for creativity, product improvement and production economy. Just look at the unique combination of properties that make Garlock Delrin* superior in many ways to metals, as well as to many other widelyused plastics.

- Metal-like strength and rigidity high dimensional stability and fatigue endurance.
- Resilience comparable to spring steel.
- Resistance to solvents unmatched by most organic compounds.
- Abrasion resistance superior to many metals.
- Excellent electrical properties.
- · Low coefficient of friction.
- Odorless, tasteless, non-toxic pleasant, smooth to the touch.

Best of all, Garlock Delrin retains these properties through a wide range of service conditions—temperature $(-40^{\circ}\mathrm{F}\ \text{to}\ +250^{\circ}\mathrm{F})$, humidity, and stress.

Add, too, important Garlock "know how"
... years of experience in the fabrication of plastics, and unsurpassed molding facilities. Result: a combination that can produce intricate shapes and custom-designed parts never before possible. Garlock design engineers can now work directly with you in creating advanced components ... parts that replace other materials and do the job better at lower cost.

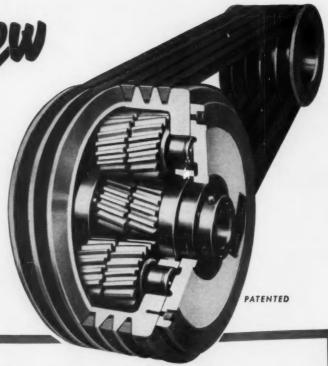
Look to Garlock as the source for all your plastic needs—Teffon* (TFE and FEP), Nylon, Polychlorotrifluoroethylene (C.T.F.E.), and many other plastic materials. For complete information on what Garlock offers in the way of materials, facilities, and technical assistance, call your local Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-177, Garlock Inc., Palmyra, N.Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd. Plastics Div.: United States Gasket Company. Order from the complete line of quality Garlock products... Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts.

*DuPont Trademark

Most versatile transmission ever developed!



With these standard accessory features



SPRING REACTION ARM

Incorporates a series of leaf springs which provide pro-gressive overload capacity, reduce shock loading, and prevent internal damage to the unit.



FRICTION REACTION ARM

A spring-loaded friction clutch combined with the reaction arm assembly. Designed to slip at a preselected torsional overload. Restores normal operation automatically when overload ceases.



MANUAL FRICTION CLUTCH

Permits manual engagement and disengagement of the unit. Provision is made for adjusting the clutching pres-sure as well as compensating for wear.



ELECTROMAGNETIC CLUTCH

This modification of the manual friction clutch provides remote control of the unit by means of solenoid actuation.



TORQUE RELEASE ASSEMBLY TYPE "A"

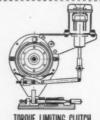
A mechanical attachment— integral with reaction arm— which provides complete dis-engagement when a pre-selected torque is exceeded.



TORQUE RELEASE **ASSEMBLY**

TYPE "B"

A mechanical at-tachment—sep-arately mount-ed—which pro-vides complete disengagement when a prese-lected torque is exceeded.



TOROUE LIMITING CLUTCH

Mechanical modification of the electromagnetic clutch assembly to provide auto-matic disengagement when a preselected load is exceeded.



DIRECT MESH ATTACHMENT

Permits 2-speed operation through a manually operated clutch mounted on reaction hub.



Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY . Offices in Los Angeles and Dallas

For complete information, write for Catalog IR-61 or contact our nearest office



Small parts for big equipment stand up better when they are centrifugally cast by Shenango

When manufacturers of rugged, heavy-duty equipment order bushings, bearings, sleeves, seals, liners, rings or other symmetrical small parts, they quite frequently specify Shenango centrifugal castings. There is good reason for this. Precision spin-casting by Shenango always provides a dense, even grain structure which means more resistance to shock and wear. Also, since Shenango operates one of the country's largest and most modern and efficient centrifugal foundries and machine shops, large orders are filled with speed and precision. Send us your inquiry today.

CENTRIFUGAL CASTING DIVISION

the Shenango

FURNACE COMPANY

DOVER, OHIO

THIS IS SHENANGO!







nig iron and co



ant molds and stools



ols | centrifugal cast

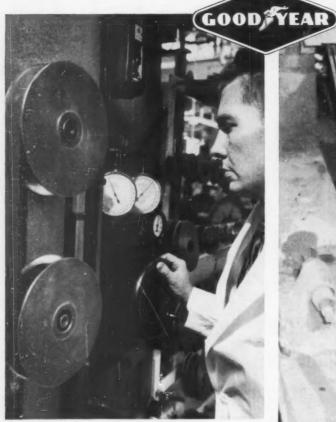


lake transportation

Copper, Tin, Lead, Zinc Bronzes • Aluminum and Manganese Bronzes • Monel Metal • Ni-Resist • Meehanite Metal • Ductile Iron

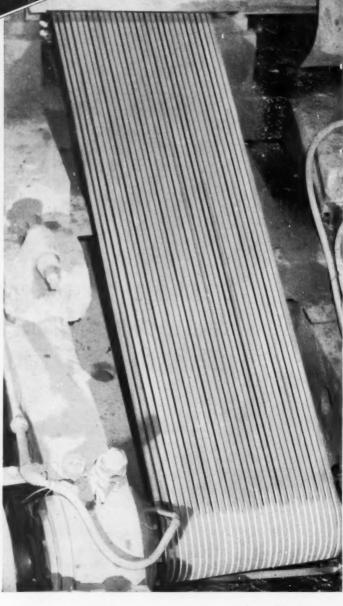
Circle 255 on Page 19

GOODYEAR EXCLUSIVE! IS YOUR SIGN OF V-



Goodyear V-Belts' precision matching comes from this exclusive close-tolerance matching equipment that length-codes each belt to 1/32''. Most other belt manufacturers code only to 1/10''.

Goodyear V-Belts' precision matching assures standout performance. Example: only 28 COMPASS-V-Steel Belts handle this big steel saw, normally calling for 42 belts. Result: the steel mill saved \$500 at the original installation — will save more at every belt change.



THE GREEN SEAL BELTS CODED TO 1/32"



Here's your assurance that every belt in a set matches in length-pulls together for maximum trouble-free horsepower hours

What's more, the Green Seal means-

Dimensional stability that lasts the life of the belt—thanks to shrink- and stretch-resistant "muscles" of 3-T Process Cord or airplane-type steel cable built into each belt.

Satisfactory performance even when subjected to dampness – because of special mildew-inhibited compounds.

The most complete line of V-Belts anywhere today – always within easy reach through a nationwide network of distributor stocks.

The proper selection of V-Belts to meet your requirements with the help of the G.T.M.— Goodyear Technical Man — America's top belting specialist.

So make the GREEN SEAL your sign of savings—in both time and money—by calling your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

Lots of good things come from

GOODFYEAR

INDUSTRIAL PRODUCTS

Green Seal, Compass -T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio



Electro-Pack CLUTCH-BRAKE DRIVE

Complete new "package drive" puts automatic cycling on your machines without engineering . . . without machining!

Preassembled! Prealigned!

Just bolt it down and wire it up!

This ready-to-install Warner "package drive" gives you a fractional hp clutchbrake unit assembled and ready to couple to an input and output shaft. Simply bolt it in place, hook up the lead wires and it is ready to go—without costly engineering or machining!

Rugged, reliable design

City_

Lightweight and compact, the

ELECTRO-PACK delivers highcycle performance with rapid heat dissipation and freedom from maintenance. Sturdier, widespread, long-life bearings run cooler under all conditions.

Simple assembly, standard components

The ELECTRO-PACK incorporates standard Warner units, available all over the world. Service is simple, alignment fast and positive.



Get-detailed specifications on this new Warner Electro-Pack Clutch-Brake Drive Package—fill in and mail coupon now.

WARNER ELECTRIC

Warner Electric Brake & Clutch Co., Dept. MD-9, Beloit, Wisconsin I'm interested! Send me full details on the new Electro-Pack Clutch-Brake Drive.

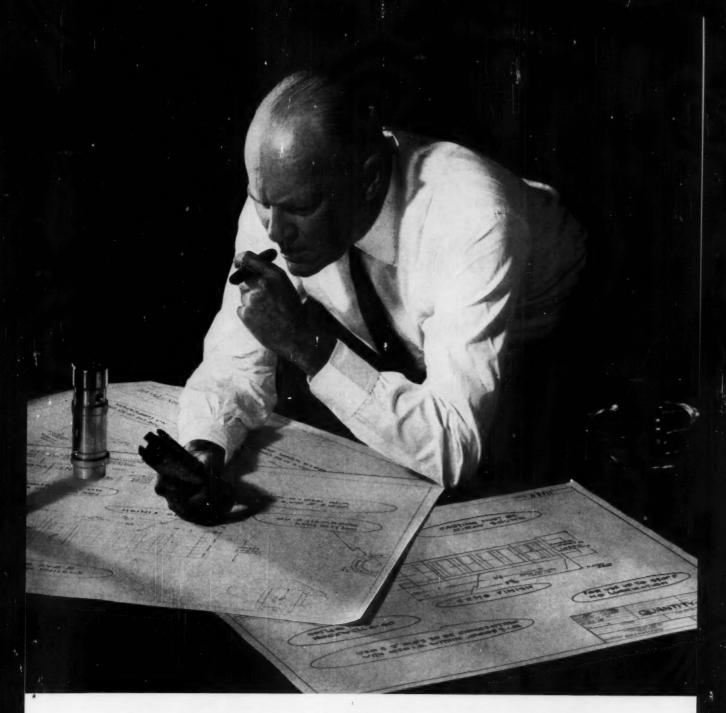
Name_____

Title_____

Address

Zone___State_

Stocked by Distributors in Principal Cities Throughout the World



I need a bushing that will last more than a month!

His problem: Metal-to-Metal wear that led to seizing and galling and then . . . quick failure. His remedy? Well, the use of a HAYNES cobalt-base alloy could be the answer.

These alloys have low coefficients of friction and are unusually long lasting under Metal-to-Metal wear conditions . . . ideal for bushings and sleeves. And they can be supplied in the exact shape, to the exact dimensions, and with the type finish needed to do the job.

But HAYNES alloys can do more than solve bushing problems. They are used universally . . . wherever metal parts that must take a beating are required. To help you get acquainted with the characteristics of these alloys, write for our 32 page book.

Address Inquiries to Haynes Stellite Company, 270 Park Avenue, New York 17, New York
Circle 258 on Page 19

HAYNES

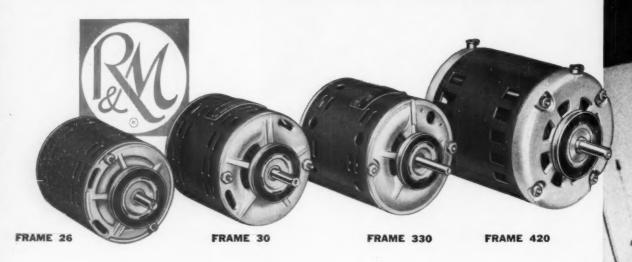
HAYNES STELLITE COMPANY

Division of Union Carbide Corporation, Kokomo, Indiana

UNION CARBIDE

The terms "Haynes" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

YOU CAN SEE THE EXTRA DEPENDABILITY BUILT INTO R&M FRACTIONALS!



new broad line offers ratings from 1/100 through 1/3 hp!

R&M's Special Application AC Motors feature extra dependability for your customers and offer wide design flexibility to you! Silent operation, compact size and minimum maintenance make these FHP motors ideal for powering office appliances, fans and blowers, small motor driven tools and countless other products. You can select from four frame sizes, 3" through 4¾" dia.; sixteen ratings from 1/100 through ½ HP; two, four and six pole speeds; three mounting arrangements; and four electrical types—capacitor start induction run, split phase, permanent split capacitor or polyphase.

For long-life operation, Mylar is used to line the burr-free slot cells. Mylar has 8 times the dielectric strength of conventional insulation and stubbornly resists tearing and aging, to provide virtually permanent protection. Venturi baffles in each end head direct fandriven air over and around coil ends in a "washing" action that quickly carries off heat, keeping the motor well within its rated temperature rise. The absence of centrifugal mechanisms and brushes further minimizes maintenance problems.

R&M Special Application Motors are available in standard off-the-shelf designs. Should you require a special custom motor, R&M will recommend the optimum design, at no obligation. Write today for new R&M bulletin 445-MD

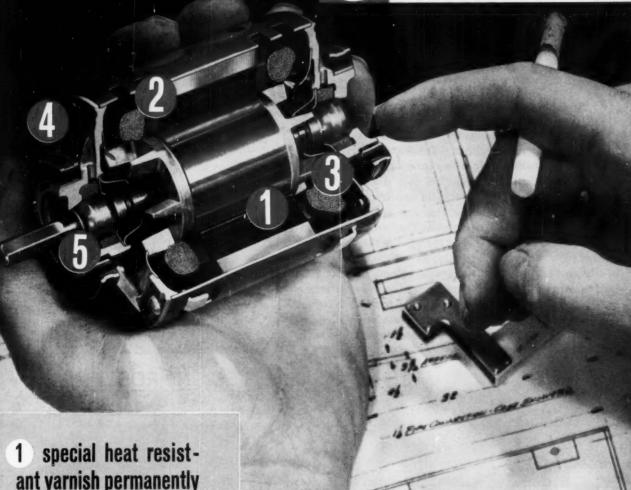
ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno Industrial Pumps
Propellair Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.



FRACTIONAL MOTORS

special application



- ant varnish permanently insulates field.
- 2 Mylar* insulation locked in burr-free slots.
- high velocity air flow cools motor windings.
- 4 lightweight, die-cast aluminum end heads.
- choice of sleeve or ball bearings.

*DuPont registered trademark.





mounting styles



rigid base mounting

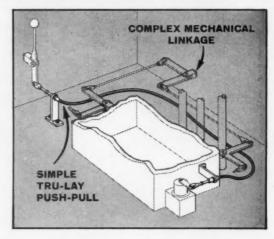


resilient base mounting

ACCURATEREMOTE CONTROL FOR HUNDREDS OF PRODUCTS

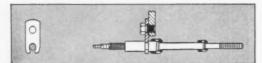
-- with Tru-Lay PUSH-PULL Controls

If your products involve remote control—electrical, hydraulic, pneumatic or direct—Tru-Lay push-pull flex-ible controls can help solve your design problems. They provide positive remote control over short or long distances—up to 150 feet from the control point. Because they operate while flexing, they can snake around obstructions. They will not buckle. They are ruggedly constructed, easily installed and operated, sealed against dirt and moisture, and will handle jobs with as much as 1,000 lbs. input. Push-pull controls are simple, have but one moving part, are noiseless and give a lifetime of accuracy. Mechanical linkages, on the other hand, are complex. Unlike Push-pull controls, they are made of many parts, wear at many points, and produce increased backlash, vibration rattles and lost accuracy.

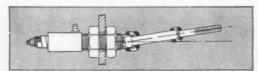


THESE FEATURES HELP SOLVE DESIGN PROBLEMS

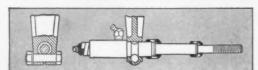
Anchorages



Clip anchorage · a simple clip for light loads

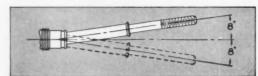


Bulkhead anchorage · for heavy-duty installations



Machined bracket anchorage • can be furnished for mounting any PUSH-PULL cable at the swivel terminal

Swivel Action



Standard assemblies have end fittings with a swivel movement of \pm 8° to compensate for misalignment and rise or fall of lever arms. Swivel joints, and the sliding ends, are sealed against dirt and moisture.

PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY, IMPROVE DESIGN



 Write for your PUSH-PULL Data File. It contains a complete set of engineering bulletins which describe in detail the operation of PUSH-PULL CONTROLS, their applications, features and advantages.

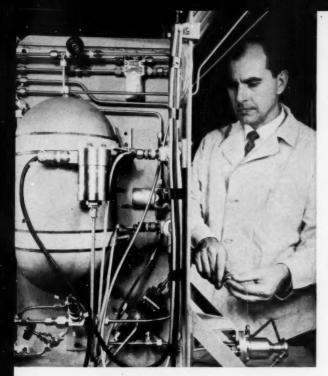


PUSH-PULL CONTROLS

Automotive and Aircraft Division . American Chain & Cable Company, Inc.

601-A Stephenson Bldg., Detroit 2

6800-A East Acco Street, Los Angeles 22 · 929-A Connecticut Ave., Bridgeport 2, Conn.



Special test facilities developed by Vickers Research and Development teams are used to evaluate nozzle designs, fuels, controls, instrumentation, etc. This setup is used in hypergolic bipropellant studies.

CAPABILITY is spelled

a-t-t-i-t-u-d-e c-o-n-t-r-o-l

Selection of the optimum attitude control system for a particular missile or space vehicle requires special technical skills, facilities for conducting the necessary test program, and knowledge solidly based on related experience. All these are available "in quantity" at Vickers.

Actual experience dates back to hot gas servo studies initiated in 1955 and now covers the additional areas of hydrogen peroxide-powered reaction control, hypergolic bipropellants and secondary injection systems using either liquid (freon), or hot gas bled from engine combustion chambers.

The facilities and skills responsible for these developments in attitude controls are available to you as a vital aid in solving the problems of space-flight orientation. For more details, write for Bulletin A-5264, and/or call the Vickers' Application Engineer in your area. He is a thoroughly experienced practitioner in the "Programed Power" field.



WE BROKE A DOZEN SCREWS, BUT

we couldn't make this sheet metal insert spin in its hole!

THE INSERT PROBLEM

A hole punched in thin sheet metal doesn't provide enough surface for threading. You often have to supply the threads by installing an insert.

But the same hole doesn't provide much surface for *gripping*, either. The insert spins.

WHAT WE DID ABOUT IT

The insert we tested was designed with an *angular* knurl around a cone-shaped gripping perimeter. Here's what happened:

First: When we mated the sheets, put in a screw, and tightened it in the insert, the screw pulled the insert toward the sheet. It also pulled the teeth of the angular knurl more firmly into the edges of the hole, increasing their resistance to spin.

We broke screws (No. 8, 10, 12, and 1/4 sizes) by overtorquing them. But the only effect on the insert was to tighten it.

Second: When the insert was first pressed into the hole, the angular knurl displaced metal, squeezing it toward and into a groove around the bottom of the insert. This locked the insert against being pushed out before the screw was tightened. After tightening, the lock was intensified by the added squeezing pressure of the angular knurl.

WE'LL SEND SAMPLES

If you've had this insert problem, drop us a line on your letterhead. We'll send some Southco THREDS (that's their name) for you to try. No obligation, of course. Write Southco Div., South Chester Corporation, 237 Industrial Highway, Lester, Pa.

THREDS...AND THE ANGULAR KNURL PRINCIPLE

Southco THREDS are installed by pressing into a single hole in the sheet, provide thread length equal to or greater than that of a standard nut. One insert fits any sheet thickness (see minimum requirement, last column in table below). Material is case hardened steel, Cad. plated per Fed. Spec. QQ-P-416 Type II, cl. 2, yellow iridite.

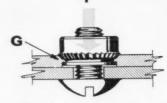
ANGULAR KNURL (detail)





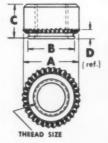
Teeth bite into edge of hole, force metal into locking groove at base of insert.





Additional torque on screw increases force F, pulling teeth of angular knurl more firmly against sheet and putting extra pressure on metal in locking grove G.

SOUTHCO THREDS $^{\text{I.M.}}$. SPECIFICATIONS



THREAD SIZE	PART NUMBER	A	В	C	D	Weight per M (lbs.)	Min. Sheet Thick- ness	
4-40 NC	74-11-104-13	7/32	.185	₹52	3/4	1.22		
6-32 NC	74-11-106-13	%2	.247	3/32	3/64	1.99	.036	
8-32 NC	74-11-108-13	5/16	.278	₹6	3/4	2.87		
10-24 NC	74-11-110-13	346	.278	3/16	364	2.51	.048	
10-32 NF	74-11-210-13	3/16	.278	3/16	3/64	2.53		
12-24 NC	74-11-112-13	13/32	.372	₹6	1/16	4.56	.060	
1/4-20 NC	74-11-125-13	13/52	.372	3/16	1/16	4.28		
1/4-28 NF	74-11-225-13	13/52	.372	3/16	1/16	4.32		

SOUTHCO FASTENERS

WHY HEAT TREAT?



BL 6111

STRAIN-TEMPERED

Unique combination of 8 properties

Why do you bother with the costs and troubles of heat treating your machined parts? Make them out of Strain-Tempered bars, another Bliss & Laughlin first.

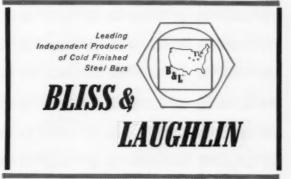
Strain-Tempered can be tailored to meet your field service requirements for:

- High tensile, yield, fatigue and torsional strengths (tensiles approaching 200,000 psi)
- Excellent machinability
- · Dimensional stability
- · Comparable wearability
- · Uniformity

You pay only for the strength and machinability you really need. In Strain-Tempered steels the selection is wide, from the industry's most complete line of high strength cold finished steel bars. This includes both carbon and alloy analyses, leaded or unleaded.

Let us show you how Bliss & Laughlin can cut your costs and get rid of your heat treating headaches.

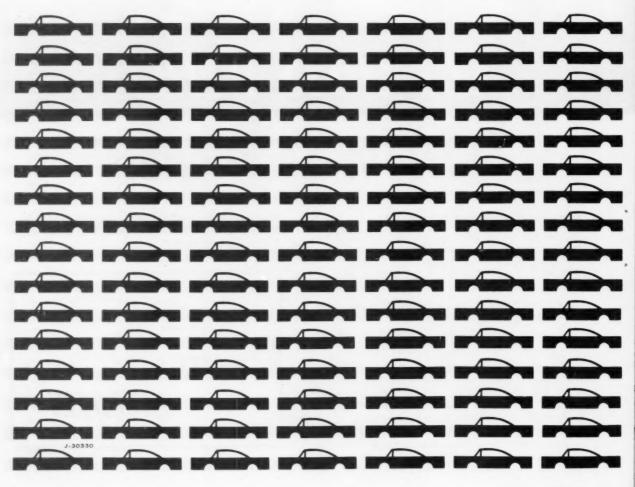
Bliss & Laughlin has been producing cold finished steel bars for 70 years, Strain-Tempered bars for 30 years. Call on this experience!



GENERAL OFFICES: Harvey, Illinois MILLS: Harvey, Ill., Detroit, Cleveland, Buffalo, Mansfield, Mass., Los Angeles, Seattle

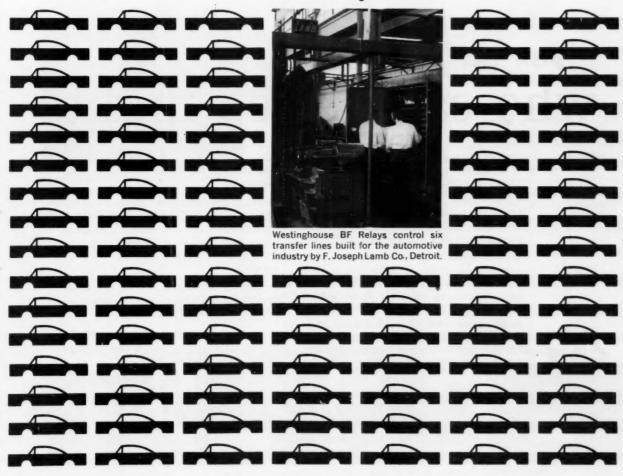
The Westinghouse BF Relay is helping the automotive industry solve its floor space problem. One automotive customer was able to reduce the length of a single control panel from 36 feet to 22

feet. Another eliminated one of three panels. The Westinghouse BF Relay is a new concept in relay design tailored to space-saving needs of automation. As many as four BF Relays fit in the space of



one old style relay. Besides being small, performance excels other machine tool relays. Learn how it can help you gain valuable floor space for more productive uses. Contact your Westinghouse sales engineer or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania. You can be sure . . . if it's Westinghouse

Automotive industry saving thousands of dollars in floor space with the new Westinghouse BF Relay





FOR THE ENGINEER

who can't sleep nights

If you're losing sleep over a sticky problem in automatic control, AE can help-because AE has a reputation for making things work automatically.

It's not surprising, considering our unique experience in the design of circuits and components for automatic telephone exchanges.

What's more, AE relays and stepping switches are unique in their own right because they're built to have substantially zero variation in operating characteristics

As an example: the AE Class B Relay, illustrated, provides hundreds of millions of operations with unfailing contact reliability, and seldom needs maintenance. For this

reason, it is probably the most inexpensive relay you can use where infallibility is an essential.

AE relays and stepping switches are custommade to your specifications - and are also available wired and assembled into complete control units. And we're always glad to suggest specialized circuits that may cut your end costs.

Want more information? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

Also yours for the asking: Circular 1702-E, Relays for Industry, and a new 32-page booklet on Basic Circuits.





AUTOMATIC ELECTRIC

Subsidiary of Subsidiary of
GENERAL TELEPHONE & ELECTRONICS





Nuclear submarines like the SKIPJACK are designed to carry out underwater missions in utmost silence. That is why the hushed quietness of Hoover Quality ball bearings makes them ideal for critical applications on this and many other types of equipment.

quiet. Hoover Honed bearing raceways are super smooth, superbly finished. Micro-Velvet balls are spherically accurate within millionths of an inch and surface finished to microscopic perfection. These precision components work together in perfect harmony. We, at Hoover, know because every Hoover Quality bearing is checked electronically before it is shipped.

Hoover Honed and Micro-Velvet are Hoover Trademarks

BALL AND BEARING COMPANY

Offices and

5400 South State Road, Ann Arbor, Michigan 8581 South Chicago Ave., Chicago 17, Illino 290 Lodi Street, Hackensack, New Jersey 2020 South Figueroa, Los Angeles 7, California

hoover controls hoover quality from start to finish



High quality wire from which balls are made is produced by Hoover's Cuyahoga Steel and Wire Division.



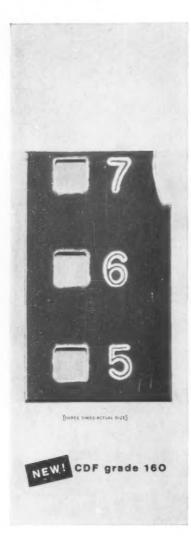
Hoover Micro-Velvet Balls are made of the finest of chrome alloy steel. Sphericity is measured in millionths of an inch.

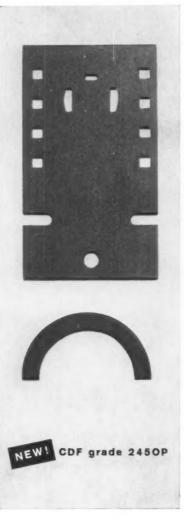


It's easier to strike a match on plate glass than on the smooth finish of a *Hoover Honed* bearing raceway.



Hoover quality control methods include non-destructive electronic inspection of bearing components.







three outstanding new laminates!

High legibility letters, numbers or symbols can be stamped on this new warm punch, paper phenolic grade in the same die used for blanking and piercing! No separate operation is necessary . . , no registration problems. Markings are permanent and in sharp contrast. Ideal for capacitor caps, terminal boards, panels, spacers, coil ends, socket bases. Meets NEMA X and XP requirements.

Economical paper phenolic grade 2450P can be punched warm and has improved mechanical strength and lower moisture absorption properties. It is designed especially for mechanical and low voltage electrical insulation applications such as connector blocks, coil and bobbin ends, washers, plug and socket bases. Meets NEMA X and XP requirements.

Excellent wet electrical and other improved properties make this new copper-clad glass fabric Teflon* laminate ideal for radar insulation, missile antennas, critical computer applications. Circuits based on this grade will show minimum drift under varying temperature and humidity. Also available without copper for such uses as high frequency insulation in wave guides.

These are the newest materials of CDF research and engineering, developed to give you outstanding performance at minimum cost. Your inquiry is welcomed. *Du Pont trademark



CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE . A SUBSIDIARY OF THE -Built COMPANY

Hamilton

DRAFTING EQUIPMENT

actually pays for itself

in increased efficiency



NEW Torsion AUTO-SHIFT Drafting Table

This new Hamilton drafting table combines truly imaginative engineering with an intimate knowledge of today's drafting procedures. It offers exclusive "freedom from fatigue" features, plus a new design that can provide space economies of up to 47%. Investigate the EXTRA/EFFICIENCY only Hamilton delivers!

Hamilton Manufacturing Company, Two Rivers, Wisconsin

EXCLUSIVE TORSION BAR MECHANISM

permits effortless fingertip boardtilt adjustment. Counterbalance compensates for weight added to board by drafting machines, lamps.

COMPLETE FILE-

REFERENCE FLEXIBILITY

File-reference facilities may be installed for use at either side of table-to fit any layout, tailoring the table to the draftsman, not the draftsman to the table.



Hamilton brings

EXTRA EFFICIENCY

to your drafting facilities
through planned layout and
superior equipment performance

UNIT SYSTEM FILES

Maximum protection and steepe capacity in minimum space. Each allow drawer has an exclusive tracing lift mechanism so that every tracing becomes a top sheet, instantly accessible. Unit files stack in the arrangement that fits your needs and can be added to as your requirements grow.

NEW MODUCOR FILES

Smart, modern, practical—MODUCOR is the better way to file roll tracings in limited space, with a minimum investment. Three different tube sizes, with spring-activated doors, and label holders. Standard module construction permits integration with other Hamilton file units.



Other Hamilton EXTRA EFFICIENCY Drafting Equipment...



CL-100 Tables

Steelwood Drafting Tables



Four Post Drafting Tables



Tracing Tables

L-CONTOUR DRAFTING TABLE

A personalized work area unit for your top-level designer-engineer draftsmen. Completely flexible counterbalanced board combines with personal rightor left-hand reference and storage facilities to give you maximum efficiency and productivity.

Hamilton

Manufacturing Company Two Rivers, Wisconsin

SUCCES Studies in Silicones HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

Do You Control Motion? Restrain, Release It? Silicone Fluids Are Helping Rewrite the Rules

Need a big-muscled spring to fit a pintsize space? You can now get a fluid spring 1/40 the size of an equivalent coil spring. Need a hydraulic shock absorber with a "flat-topped" energy absorption curve between minus 60 and plus 500 deg. F.? You can now get it. Want the two in one unit? You can get that, too.

The common denominator of such high-performance devices is a series of UNION CARBIDE Silicone Fluids. They range in viscosity from 10 centistokes to 100,000, with pour points as low as minus 85 and flash points above 600 deg. F.

MILLION POUND CAPACITY. This revolution ary, patented 1,000,000-pound Taylor liquid spring utilizing the precisely known compressi-bility of UNION CARBIDE Silicone Oil, is said to be the highest force spring ever produced in a single unit. Only a foot in diameter, it could support three of the largest locomotives. On top of it sits Taylor's smallest liquid spring. Beside it is a locomotive coil spring of almost the big spring's size, but providing only 10 tons of force.

COMPRESSIBILITY PLUS STABILITY

Two of silicone fluids' outstanding properties contribute greatly to their growing usefulness in a variety of hydraulic devices including springs, shock absorbers, torque convertors, dash pots, valve lifters, many more. These are compressibilitythe highest known for polymeric fluidscombined with stability at temperature extremes.

The per cent compressibility of Union CARBIDE L-45 and L-527 Silicone Fluids, compared to conventional mineral oil, is shown in the accompanying chart. The viscosity temperature coefficient V210°F. \ for L-45 with nominal V100°F.

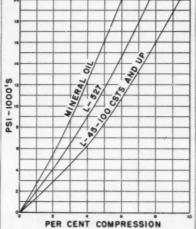
viscosity of 100 ctsk. is 0.63.

NAME YOUR OWN SPRING RATE

Taylor Devices, Inc., of North Tonawanda, N. Y., is one of the companies adapting these highly useful qualities to hydraulic equipment. In tension and compression devices, for example, using a stepped tubular piston design and L-45 fluid, they achieve virtually any desired spring rate and force, within a compact, structurally stable mechanism.

Again, in spring-shock absorbers where high mechanical energy is converted to heat energy, Taylor Devices find Union CARBIDE Silicone Fluids greatly extend the useful work range of the units.

Among the jobs such devices are per-



Compressibility of Union Carbide Silicone Fluids vs. Mineral Oil

forming are: Scram-rod cushions in nuclear reactors, taking impact loads on aircraft arresting hooks, cushioning aircraft radar antennas. In addition, they arrest circuit breaker mechanisms at interruption, stop rolls of paper on paper machines, and control feed rate of electrodes on electric furnaces.

R AND D TO HELP YOU

If you design hydraulic equipment for tough duty, your Union Carbide Silicones Man has a wealth of technical know-how on the ways Silicone Fluids can help you obtain outstanding performance. Behind him are the vast experience and research of Union Carbide Corporation in virtually every field of industry.

We invite you to send at once for our comprehensive "Design File" on Union CARBIDE Silicone Fluids for Mechanical Applications. It gives you in one handy package just about all you need to know about silicone fluids for your design requirements. Mail the coupon today,

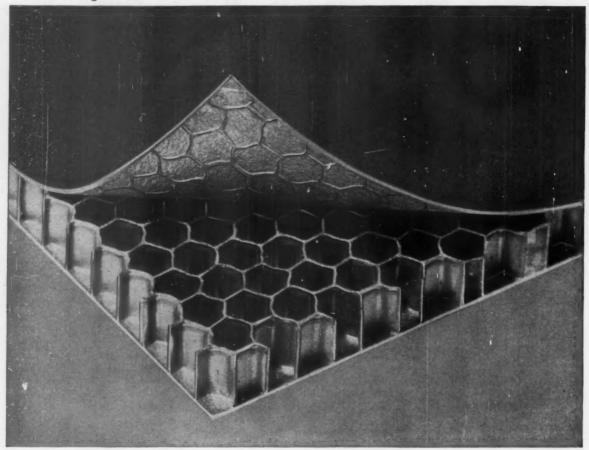


SILICONES

Union Carbide is a registered trade mark of Union Carbide Corporation.

Silicones Division Union Carbide C Dept. 1L-4106, Long Island City	orporation 30-20 Thoms	on Avenue
In Canada: Union Bakelite Division		
Please send me Union Carbide S ical Applications	ilicone Fluid	
Name		
TITLE		
COMPANY		
Address		
Сіту	ZONE_	STATE_

Metallurgical Memo from General Electric



How do you hold together a supersonic sandwich?

With a brazing alloy that becomes an integral part of the entire assembly . . . that's General Electric's vacuum-melted answer

In brazing honeycomb laminations for hightemperature, high-strength applications, selection of the brazing alloy is at least as important as the metals to be brazed. If the braze is inadequate, the entire assembly is useless.

General Electric's vacuum-melting process produces

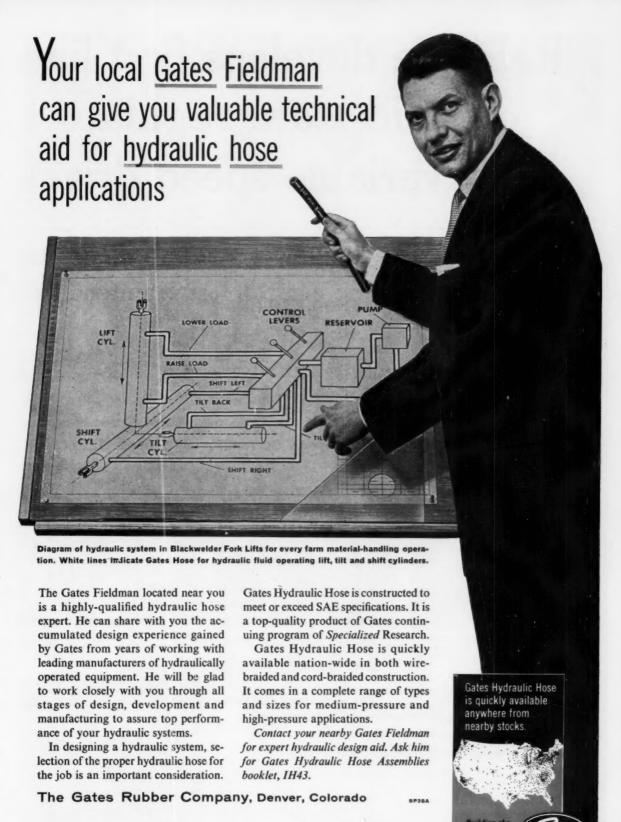
a brazing powder for honeycomb applications which has exceptionally low erosion characteristics and offers top strength even up to 1800° F.! It also provides superior "filleting" characteristics for better stress distribution in brazed joints.

In addition to alloys for honeycomb brazing, G-E offers vacuum-melted brazing powders for general purpose and wide-gap applications. Each is of highest purity, uniformity, and reliability. May we send you additional information? Write: Metallurgical Products Department of General Electric Company, 11159 E. 8 Mile Blvd., Detroit 32, Michigan.

METALLURGICAL PRODUCTS DEPARTMENT

GENERAL (ELECTRIC

CARBOLOY® CEMENTED CARBIDES . MAN-MADE DIAMOND . MAGNETIC MATERIALS . THERMISTORS . THYRITE® . VACUUM-MELTED ALLOYS



Gates Hydraulic Hose

Reliance develops first line of solid state regulators for variable speed drives

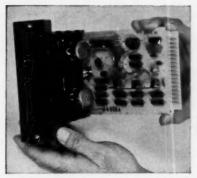
... gives you better circuits, precise control, less maintenance.

Reliance has produced the first complete line of solid state regulators and exciters for variable speed (V*S) drives and Engineered Drive Systems. These new devices, using power silicon rectifiers and diodes in place of tubes, achieve precise motor control, 1/10% regulation at base speed, with response times up to twice as fast as tube-type regulators. Here is a major advance in variable speed control, and a major advantage for the industrial user. Reliance Drives with these new regulators are now available to you in 1 to 1500 horsepower.

Reliance research and development brings you a more efficient drive than ever before . . . and a notable refinement of already well-engineered systems.

The pictures on the facing page tell the story.





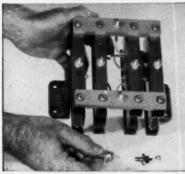
1. Heart of the system is new "Cardpak" control circuit, with transistors, capacitors and resistors to amplify feed-back signals.



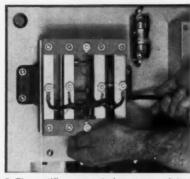
2. Each plug-in "Cardpak" module is a complete control circuit...can be quickly checked and easily replaced, if ever necessary.



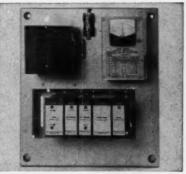
3. Each V*S Drive control system is tailored to your specific job . . . with "Cardpak "circuits pre-engineered for reliability, fast delivery.



Power silicon controlled rectifiers and diodes, instead of tubes, are among the most reliable components yet devised.



The rectifiers, mounted on copper plates for heat radiation, operate over a wide temperature range with no special cooling.



6. Complete panel can be checked quickly for start-up and trouble shooting with the optional test fixture...one meter, one knob.



7. Motor control is precise ... 1/10% regulation at base speed, with response times up to twice as fast as tube type regulators.



8. The Reliance V*S Drive control cabinet is 35% smaller than conventional drives. Cabinet can be located where convenient.



9. Operator's station centralizes drive operation. Multiple stations, bench boards, pendent stations and special controls available.



10. The Super-T D-c. Motor...integral part of the V*S Drive. It's rugged...absorbs repeated 100% overloads for one full minute.

Your nearest Reliance Systems Engineer will give you all the facts...help you apply Reliance V*S Drives to your products and processes. Call him through the Yellow Pages, or write us direct.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 28-9, CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

GASKET SEALS vs. FLANGE FINISH

Smooth flanges usually help simplify gasket problems . . . but they raise machining costs. Can a gasket material compensate so well for flange roughness that machining costs can be reduced?

E. M. SMOLEY
Research Physicist
Armstrong Research and Development Center

How smooth do flange surfaces in gasketed assemblies have to be? Is there a gasket that will seal so efficiently that less machining of flange surfaces might be practical?

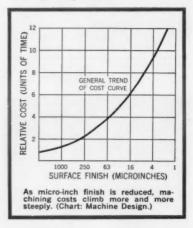
To answer these questions, extensive tests were conducted at the Armstrong Research and Development Center, using rough (3000 microinch) and smooth (5 micro-inch) flange finishes.

Two different gasket materials were compared: one, a standard grade of as a function of time by the electromechanical air leakage tester developed by Armstrong engineers.

Many individual tests were run, using two smooth flanges, two rough flanges, or one of each. The results are condensed on the chart below.

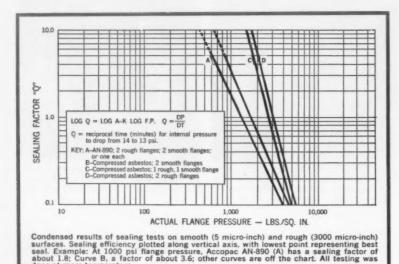
The curves show that AN-890 Accopace has far better sealability with either rough or smooth flanges—or one of each—than the compressed asbestos material. Even at the relatively low flange pressure of 1000 psi,

The patented beater-saturation process gives a more uniform dispersion of rubber on fiber—hence, AN-890 is a more compressible material. As a result, it has unusual conformability to flange irregularities.



These tests indicate that Accopac AN-890 offers definite promise of efficient seals at higher micro-inch flange finishes. Its use can make possible savings in machining costs that are well worth considering.

Research on gasket performance is a continuing project at the Armstrong Research and Development Center. Our large library of data may already contain the answers to your specific sealing problems. We will be glad to make suggestions if you will send details to us. Address Armstrong Cork Company, 7109 Dean Street, Lancaster, Pennsylvania.



compressed asbestos; the other, Armstrong Accopac AN-890, a beater-saturated rubber-asbestos material. Both were 1/32" gauge.

done at room temperature.

In each test, air was locked in gasketed flange assemblies at an internal pressure of 14 psi. Then pressure loss was measured and recorded the unusual sealing ability of AN-890 is evident.

The superior performance of AN-890 is a result of the way it's made.

Armstrong GASKET MATERIALS

TEAMWORK BEATS SCHEDULE IN MARKETING FIRST CORDLESS DRILL

DIES DESIGNED AND CASTINGS DELIVERED IN THREE WEEKS BY DOEHLER-JARVIS!

A 'breakthrough' product means a race against time. Get it in production and on the market while it is still "hot" news.

That was the situation Black and Decker faced in developing the first "cordless" electric drill.

A major time factor-the design and construction of dies and the die casting of three major elements of the revolutionary new product.

The question put to Doehler-Jarvis-can you design and build the dies and deliver aluminum castings for the gear case, gear case cover and field case in three weeks?

The answer-we did it!

The first delivery of completed castings was made in three days less than three weeks.

This is not a routine situation. But it is an outstanding example of how Doehler-Jarvis' 57 years of leadership in die casting can work to your benefit in all circumstances. It was the design and engineering skill and experience of Doehler-Jarvis, together with their unmatched production facilities and know-how which helped Black and Decker meet its ultra-tight production schedule.

But there was more to gain than speed. The die cast parts delivered to Black and Decker have the high strength, impact resistance and abrasion resistance needed to take rough handling; they are sound and dimensionally stable to permit and maintain close tolerance; and their attractive finish adds extra sales value.

You will find it to your advantage to talk to Doehler-Jarvis about die castings for your products. Contact the office nearest you.



Doehler-Jar

Plants and Sales Offices: Toledo, Ohio; Grand Rapids, Michigan; Pottstown, Pennsylvania; Batavia, New York.

rennsylvania; Batavia, New York.
In Canada: Barber Die Casting Co., Ltd., Hamilton, Ontario.
In Brazil: Industrias Doehler do Brasil, S.A., Sao Bernardo do Campo, Sao Paulo.
In Argentina: Doehler Argentina, S.A., Buenos Aires.
In Great Britain: Metal Castings-Doehler, Ltd., Worcester, England.

SQUARE D NORDEK

NORPAK is a significant advance in the field of static switching. Like other static systems, NORPAK performs the functions of machine tool relays, stepping relays, latching relays and timers - all without contacts or motion of any kind. Like other static systems, NORPAK is ideal for applications where speed is important—where reliability and long life are essential-where conditions make conventional magnetic devices impractical.

> But unlike other static switching systems, NORpak offers the **important advantages** shown on the next page .

> > 2345678910

ACTUAL SIZE



SQUARE D COMPANY

-A SIMPLER, FASTER, STATIC CONTROL!

EASIEST TO APPLY

The transistor NOR unit is the basis of NORpak. All logic functions—AND, OR, NOT, MEMORY—can be accomplished with combinations of this single NOR unit. NORpak is not complicated—it's easy to apply to conventional circuits. Units are color-coded for quick identification. Simple DC circuit eliminates worry about phase relationships.

UNMATCHED SPEED

NORPak provides switching at rates up to 25,000 per second—faster than any other industrial static system.

SMALLEST COMMERCIAL PACKAGES

NOR pak is available in the form of individual components, or in completely engineered systems. Components are offered in 6 and 20 paks, require only 1/4th the equivalent relay panel space, and weigh less than components of other static systems.

EXTRA DEPENDABILITY

NOR units have been time-tested in computer use for years. They are not subject to wear, will give top performance indefinitely, and provide unfailing circuit fidelity.

SIMPLE TO USE

Optional monitor lights give visual evidence of proper performance. Simple dynamic sequence tester checks individual NOR units in operation.

EXPERT APPLICATION HELP

Field specialists, factory-trained in all aspects of **NORPak**, can give you on-the-spot answers to any application questions.

Norpak is available as individual components for application to specific control functions, or as completely engineered systems ranging from the smallest to the largest panels

Write for the complete story on NORPAK
 —its theory, application and operation.
 Square D Company, 4041 North Richards
 Street, Milwaukee 12, Wisconsin



wherever electricity is distributed and controlled



Universally specified for top performance and endurance



FREE brochure tells you why U. S. Axle is your best source for precision-made shafts. Write today. WHEREVER shafts are used — in products for industry, transportation, or the home — they go further and do more if they're U. S. "Custom-Engineered" Shafts. There's a reason — U. S. Axle has over 40 years of specialized "know-how" . . . backed by modern production facilities to translate your requirements into the accurate, efficient shafts you need. Precision-manufactured of finest alloy steels . . . heat-treated and shot-peened for added toughness and durability. For your next shaft application, specify the best — specify U.S.!

for prompt quotations, submit prints and specifications



Since 1920 • Pottstown, Pennsylvania



Busiest shafts in any business! When selecting roller bearing pillow blocks, remember

it's what's inside that counts!

MAXIMUM SIZE AND NUMBER OF ROLLERS for highest capacity

CENTRIFUGALLY CAST, PRECISION MACHINED BRONZE RETAINERS for smooth, quiet operation

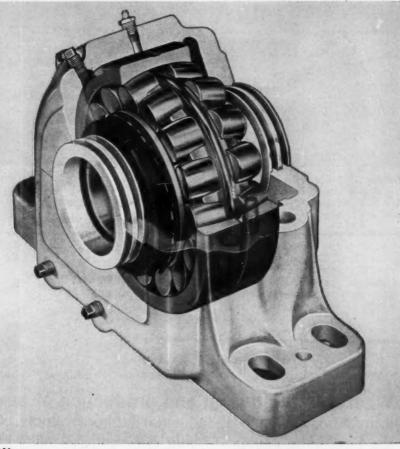
HIGH, HEAVY INNER RING FLANGES for ease of installation and removal

AND INSIDE LINK-BELT ROLLER BEAR-ING BLOCKS you'll find Link-Belt's new spherical roller bearings . . . with big, mirror-smooth, highest capacity rollers; centrifugally cast, precision machined bronze retainers; heavy, broad-shouldered inner rings. All the best features of modern bearing design compactly unitized for utmost economy and long service life.

Link-Belt spherical roller bearing pillow blocks are self-aligning. Available in adapter mounting and directshaft mounting types for shafts from 11/6" to 12". Choice of two effective seals: all-purpose steel, multi-labyrinth seals, or Dacron-contact seals. For full details,

For full details, call your nearest Link-Belt office. Look under BEARINGS in the yellow pages of your telephone directory. Ask for Book 2760.





SERIES 6800, 6900, 7800, 7900 have exceptionally rugged, two piece housings—machined as two perfectly matched parts providing easy installation.



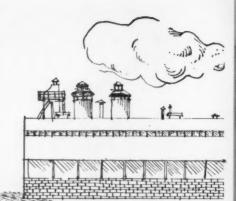
LINK BELT

SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Cartying Distributors in All Principal Cities Export Office, New York 7; Australia, Marrickville (Sydney) Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.



AT THE HEART OF INDUSTRY ...

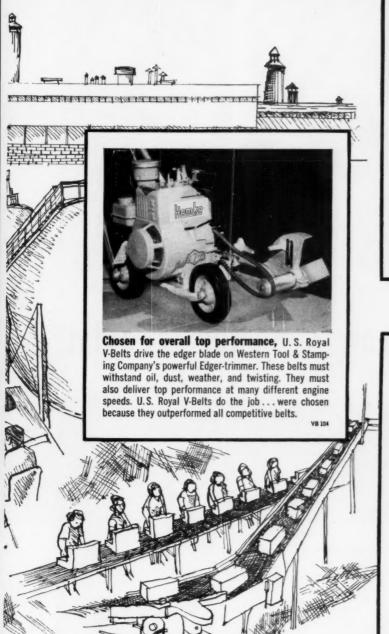




Helping to set a world speed record ... a U.S. PowerGrip "Timing"® Belt is the key link in the drive train of this Mercury outboard. U.S. "Timing" Belts' positive tooth engagement prevents slippage, insures perfect synchronization. These belts have high flexibility and strong gripping teeth, are backed by steel cord, permit more compact sheaves, need no maintenance.

TB 103

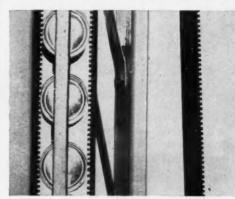
Wherever the design and production of power equipment is involved, you'll find <u>US</u> Industrial Rubber Products...helping to simplify the design, improving the efficiency and reliability of equipment both new and old, adding to the profit of manufacturer and operator alike.





Providing better steering control for Clarke's new Power Sweeper, a U.S. PowerGrip Flexible Coupling has eliminated cumbersome, costly metal parts and their need for lubrication...provides quieter, cushioned, yet responsive steering. These easily installed couplings not only compensate for lateral and axial misalignment, but reduce vibration and absorb jarring shocks.

FC 103



"Nothing short of spectacular," says an Anheuser-Busch brewery manager about two U. S. SteepGrade Conveyor Belts that lift wet 16-oz. beer cans at a 90° angle. The secret of this non-slip operation is SteepGrade's "gripper cleat" construction which holds the cans firmly, yet gently, allows less pressure and belt speed, eliminates damage to cans and smearing of print.

CB 124

For every industrial rubber product need, turn to <u>US</u>. For Conveyor Belts, V-Belts, the original PowerGrip "Timing" Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings... custom-designed rubber products of every de-

scription. Discover why U.S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U.S. Rubber Distributor or contact <u>US</u> directly at Rockefeller Center, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS.



United States Rubber

MECHANICAL GOODS DIVISION

WHAT HOOK-LOCK IS

HOOK-LOCK is a springless, positive-locking latching device which is ideally suited for use on rigidly specified military transit cases as well as less expensive commercial containers. It provides high closing pressure and tremendous load-carrying capacity...is impact and shock-proof. HOOK-LOCK is so designed that it lies flat against the mounting surface whether in open or closed position. Since operation is parallel to mounting surface, no space for operating clearance is required.





HOOK-LOCK lies flat against mounting surface, open or closed.

New-HOOK-LOCK container latch...It's flat!

FEATURES

Shock-proof—solid construction...withstands high impact blows directly on the fastener.

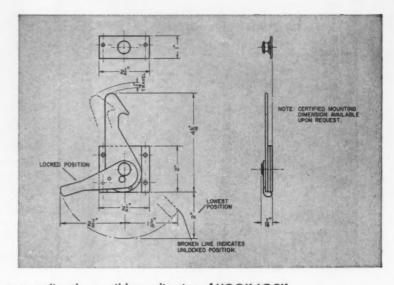
Closing pressure of 200 lb. Where needed, pull-down pressure can be substantially increased by modification of operating lever.

Tensile load capacity: 750 lb.

Compact—lies flat open or closed. Extends just 7/16" from container surface at thickest point.

Positive-locking and springless. Unaffected by arctic temperatures.

No operating clearance required, because hook and lever move parallel to mounting surface.



IF YOU have questions regarding the possible application of HOOK-LOCK or other Simmons industrial fasteners to your particular needs, your inquiry will receive our immediate attention. Contact your nearest Simmons office or write direct.

SIMMONS FASTENER CORPORATION

1756 North Broadway, Albany 1, New York

Stellat RELIABILITY and ECONOMY

CASE
HARDENED
CHROME-PLATED
ROD

"BASE-LOK"
ROD FLANGE
SEAL
(Pat. Pending)

"SHEF"
TUBING END
SEAL
(Patented)

TEFLON DIRT WIPER

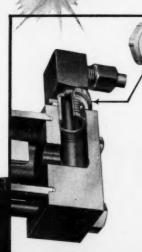
ALL SEALS
"SEAL WITH
PRESSURE"

NON-PROTRUDING CUSHION ADJUSTMENT

RUST-RESISTANT SURFACES

AIR CYLINDERS

PORT



Now-with every Miller Cylinder— Teflon-sealed Port Seals that "Seal with pressure" are provided as standard at no extra cost. They permit much faster positioning of lines and fittings, eliminate "overtightening" damage, and seal perfectly against all operating media. Here are eight more reasons why Miller Air Cylinders continue to be the most economical and reliable cylinders that money can buy. These stellar features—including the new port seals—are standard Miller construction—yours at no extra cost. Thus, they provide appreciable savings in original investment—particularly for those who insist on "J. I. C." quality throughout. Savings in operating costs are even greater, because these features are proven assurance of longer cylinder life, greater efficiency, reduced maintenance and downtime.

Specify "Miller" for greater reliability and economy! Write for bulletin.

R

MILLER FLUID POWER

7N016 York Road, Bensenville, Illinois



This compact compressor supplies 15 CFM at 5000 psi in a high pressure hose testing facility. Similar machines are available for pressures up to 6000 psi, and volumes up to 80 CFM.

A COMPACT COMPRESSOR FOR HIGH PRESSURE AIR—UP TO 6000 PSI

Joy High Pressure Compressors are easily portable, highly reliable sources for high pressure air for testing. Originally developed for military jet aircraft and guided missile programs, Joy Compressors in pressure ranges up to 6000 psi are field proven for reliability and durability. Currently, they are being used to test high pressure equipment, such as hose, valves, and fittings in numerous Research and Development installations.

These high pressure compressors are compact, multi-stage, V-type machines which are designed for continuous operation. They can be supplied for either electric or gasoline motor drive, and can be skid-mounted or equipped with wheels for complete portability.

If you have testing facilities which require extremely high pressure air, it will pay you to get complete details about the Joy machines. Write for Bulletin 1014-64B.





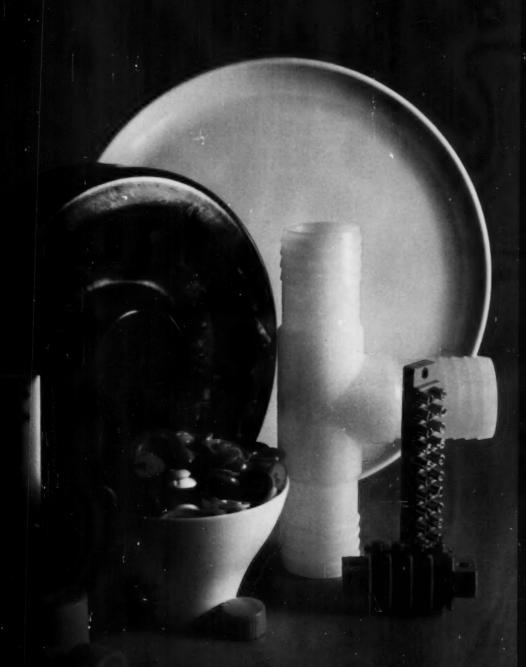






Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario



Allied

PLASKON ALKYD AND ALKYD (DAP) MOLDING COMPOUNDS ranular Type Putty Type Impact Typ **Granular Type Impact Types** PLASKON COATING RESINS

PLASKON PHENOLIC RESINS

Granular materials are designed for high-speed, fully automatic or semi-automatic molding operations. They include glass and mineral-filled grades. Contacts may be molded in or inserted in a separate procedure.

PROPERTIES

Provide high arc and insulation resistance and dielectric values which are maintained at elevated temperatures and after exposure to heat and humidity. Molded parts have unusually high dimensional stability (minimum after-shrinkage). This, plus the fact they are generally adaptable to rapid production cycles, permits endless reproduction of precision parts.

There are PLASKON Alkyd granular types that conform to the MIL-M-14F specification, Type MAG and, the poly diallyl

For encapsulation of small electronic parts where delicate inserts are to be sealed within a protective shell. Molds rapidly at extremely low pressures. Available in soft, puttylike sheets. Easy to handle -no mixing required.

PROPERTIES

For many applications the coefficient of linear thermal expansion will be found similar to popular wire types (their thermal conductivity dissipates heat faster) producing less change in dielectric performance before and after encapsulation. Conform to the MIL-M-14F specification, Type MAG.

APPLICATIONS

Resistors, capacitors, coils, transformers, small electronic

Reinforced with glass fiber for increased impact strength. Combines the electrical qualities typical of Alkyds with the high strength of glass fiber reinforcement. Also retains excellent dimensional stability characteristics of all Alkyd Molding Compound types. Suitable for compression and transfer molding.

Grades available to conform with the MIL-M-14F specification, Type MAI-30 and MAI-60; and MIL-M-19833, Type GDI-30.

APPLICATIONS

Computer parts, synchros, coil forms, terminal blocks, connectors, stand-off insulators. heavy-duty circuit breakers and switch gear.

A complete line of alkyd, urea, melamine, styrenated alkyd, silicone alkyd, modified phenolic, maleic and ester gum resins for the surface coating and printing industries.

Each resin is designed to deliver specific performance characteristics such as gloss, superior gioss retention, chemical and solvent resistance, durability and rapid drying.

APPLICATIONS

Paints, varnishes, lacquers, printing inks and self-polishing floor waxes. Exterior and interior appliance, automotive and industrial uses.

A family of outstanding thermosets. Properly applied, they result in strong, rigid, dimensionally stable products. A new pre-mix resin permits preparation of reinforced molding materials using the economical pre-mix method.

PROPERTIES

Unaffected by water, alcohol, oils, greases, mild acids and common solvents. Excellent heat resistance up to 700°F. when laminated with glass cloth. No marked change at freezing temperatures. Excellent electrical properties. Special grades offer extreme chemical resistance.

APPLICATIONS

Plaskon Phenolic Laminating Varnishes are widely used in decorative and electrical-grade laminates. New flame-retardant resins are available for switchgear and printed circuits. A special resin has been developed for aircraft and missile parts. Other uses include thermal insulation, battery separators, oil and air filters; shell molds and foundry cores.



A line of specially formulated resins for cost-saving pre-mix molding, which permit rapid production of parts of varying thicknesses, intricate contours or molded-in inserts. Molders can use their own reinforcements, fillers and catalysts.

PROPERTIES

Great strength and light weight in reinforced plastic laminates. "Built-in" molding advantages include pre-acceleration to speed production, rapid impregnation and excellent release for matched-metal molding. Plaskon Polyesters for matched-metal molding offer better mold release, higher gloss and less crazing than general-purpose resins.

APPLICATIONS

Boats, housings, translucent panels, furniture, packaging and aircraft components.

Fluorohalocarbon plastics for difficult design problems. Easily extruded, compression and injection molded. Structure retards crystallization during slow cooling cycles after exposure to high temperatures—tending to maintain toughness, flexibility and clarity.

PROPERTIES

Built-in flexibility, radiation resistance and excellent moldability. Virtually unaffected by inorganic acids, alkalies or oxidizing agents. No moisture absorption. Easy to clean. Excellent optical qualities. Transparent up to 1/4-inch cross section. Resistant to heat and cold: Type VK serviceable up to 350°F., TVS to 390°F. Thin sections can be flexed at -320°F. Good abrasion resistance, impact tensile and compressive strength. High volume and surface resistivity at high and low temperatures. Low dielectric constant and good power factor at high temperatures and frequencies. Nonflammable.

APPLICATIONS

Insulation for hook-up wire, printed circuit boards, flexible cable and cable assemblies. Coil forms, tube sockets, terminal insulators, etc. Lining material for storage tanks, pipe lining, gaskets, "O" rings, etc. Caps for containers of highly corrosive liquids.

A molding compound which provides the hardest surfaces attainable with plastics.

PROPERTIES

Excellent are resistance, hardness, lightfastness. Inert to chemical and pharmaceutical reagents. Highly resistant to electrical tracking. Tasteless and odorless. Surpasses urea in resistance to acids, alkalies, heat and moisture absorption. Varying degrees of trans'ucency permit unlimited color range.

APPLICATIONS

Dinnerware, appliance housings, electrical parts and wiring devices, cutlery handles and buttons.

New types of molding and extrusion compounds different from previously available domeatic nylon. A polymer of caprolactam.

PROPERTIES

Unusual toughness, abrasion resistance, self-lubrication, high heat-distortion temperature, high strength-to-weight ratio and good chemical resistance. Less shrinkage and superior dimensional control than other nylon types. Broader melting range—can be molded at lower temperatures and pressures. Superior impact strength, better moldability in thick sections, easier pigmentation.

APPLICATIONS

Precision parts such as gears, cams and bearings. Small tubing, shapes, small and large rod, film, laminates, wire and rope covering. Parts requiring stability against oxidative embrittlement at high temperatures. Fish line, heel lifts, pipe fittings, pipe, blown bottles.

A molding compound that comes in an extremely wide range of colors — pure white, pastels and brilliant hues. A special housing type has been developed for large parts fabrication.

PROPERTIES

Tasteless, odorless and inert. Resistant to grease, oil, solvents, heat, chipping and cracking. High dielectric strength and are resistance. Excellent dimensional stability.

APPLICATIONS

Closures, wiring devices, stove and cabinet hardware, toilet seats, lighting fixtures, radio, appliance and other housings, cosmetic and jewelry containers, buttons.



*Trade Mark

Allied (hemical

BASIC TO AMERICA'S PROGRESS

PLASKON FIRE-RESISTANT UREA UFR-28

PLASKON WOOD-FLOUR FILLED UREA A-CO POLYETHYLENE 6

A molding compound with low flame-spread rating, supplied in unpigmented natural color and a range of tint shades.

PROPERTIES

Self-supporting rigidity. UL flame-spread rating of 25 to 75. Meets fire-resistance requirements of municipal, state and national building codes.

APPLICATIONS

Lighting and appliances. Ideal for luminescent ceilings.

An improved general-purpose molding compound available in black, NEMA closure browns and large-volume special opaque colors.

PROPERTIES

Tasteless and odorless. Highly resistant to electrical tracking; excellent arc resistance and insulation properties. Hard; lightfast; inert to chemical and pharmaceutical reagents. Often performs as well as cellulosefilled urea, differing mainly in opacity and color quality.

ADDITIONS

Wiring devices, switch plates, closures, household circuit breakers and light industrial switch gear.

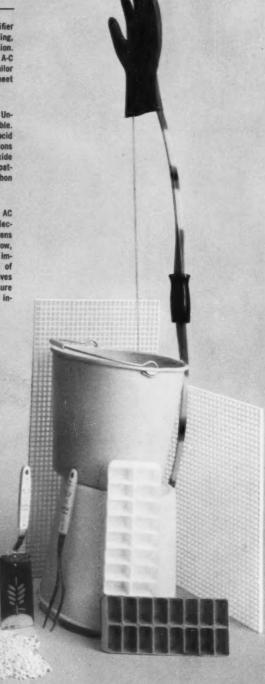
A processing aid and modifier for use in injection molding, slush molding and extrusion. By varying the amount of A-C Polyethylene 6, you can tailor the resin melt index to meet any molding problem.

PROPERTIES

Tasteless, non-discoloring. Unusually inert and very stable. Resistant to water, dilute acid solutions, and basic solutions such as ammonium hydroxide and sodium hydroxide. Compatible with most hydrocarbon polymers.

APPLICATIONS

Adding small amounts of AC Polyethylene 6 to high molecular weight resins shortens cycle times by increasing flow, improves color dispersion, improves gloss, permits use of better base resins, improves mold release, lowers pressure requirements and reduces inventory of grades needed.



Plaskon® plastics and resins are backed by the technical proficiency of Allied Chemical's applications and technical service laboratories. They are manufactured under the strictest quality controls. Write us for more information on any of these hardworking materials, or for help with design, fabrication or materials selection problems, 40 Rector Street, New York 6, N. Y.

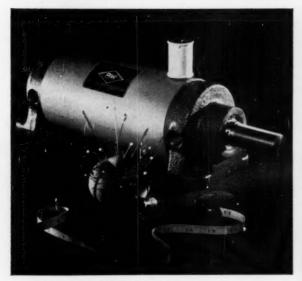




DEPENDABLE NAME, DEPENDABLE PRODUCT



QUALITY MATERIALS AND CRAFTSMANSHIP



TAILORED TO FIT YOUR NEEDS



FAST, DEPENDABLE DELIVERIES

All yours with Bendix-Westinghouse Power Cylinders

Dependability . . . quality . . . specialized engineering . . . quick delivery. If you're seeking these features in power cylinders, your best source is Bendix-Westinghouse. Our experience has been earned in nearly every imaginable application—light, medium and heavy-duty—standard and special—involving pressures up to 200 psi air and 1800 psi oil on standard models, higher on specials. We maintain a large inventory of machined parts for standard units, and offer the flexibility to

"tailor" power cylinder sizes and mounting arrangements to your needs quickly and accurately. Write or call for complete information on industrial product applications involving power cylinders from Bendix-Westinghouse.



ROTOCHAMBER has neoprene diaphragm, delivers from 900 to 5000 pounds force at 100 paid air pressure.



ROBOTAIR CHAMBER has optional rubber or neoprene diaphragm, delivers from 300 to 3600 pounds force at 100 psi air pressure.

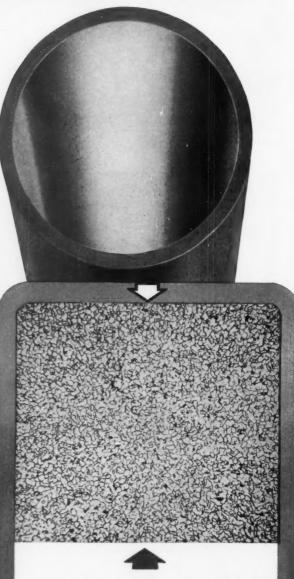
Bendix-Ufestinghouse (BW)

INDUSTRIAL PRODUCTS

Bendix-Westinghouse Automotive Air Brake Company, Etyria, Ohio

Custom Quality OHIO / COLD DRAWN

features improved physicals, closer tolerances, better finish



Arrows indicate approximate center of weld line. After normalizing, cold drawing and annealing, the weld area cannot be detected even when the polished and acid-etched surface is magnified 100 diameters. This perfect microstructure makes Ohio Drawn-Welded, in every sense, weldless — an ideal tubing for critical mechanical and pressure applications. In addition to cold drawing, a severe test in itself, non-destructive tests such as air, water, magnetic and eddy current, insure 100% acceptability.

WELDED STEEL TUBING

Now Available in Larger Sizes... Heavier Wall Thicknesses

NEWS ITEM:

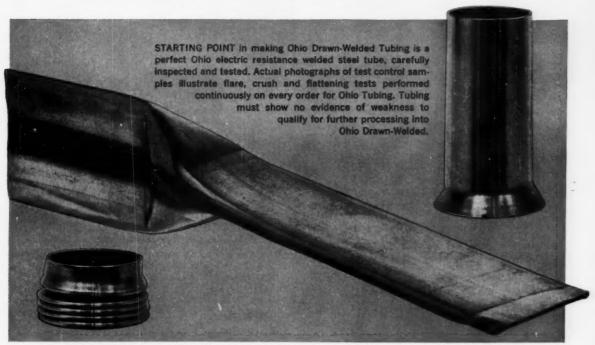
Ohio Seamless is now cold drawing quality electric resistance welded steel tubing up to 7½ inches with wall thicknesses to .344. Ohio Custom Made Drawn-Welded Tubing is here now — in greater range of sizes, wall thicknesses, finishes than ever before.

TECHNICAL ITEM:

Controlled normalizing assures desired microstructure... Precision cold drawing imparts special physical properties, assures uniform wall thickness, delivers closer dimensional tolerances and superior surface finish.

ACTION ITEM:

This all adds up to a new major-source capability that can help you design with new freedom, manufacture at lower costs. Mark your orders: Ohio Custom Made Tubing. Either welded or seamless, it's your best buy whenever tubing is the best shape.





OHIO SEAMLESS TUBE

Division of Copperweld Steel Company · SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

Representatives in principal cities. Check leading directories: THOMAS', MacRAE'S, CONOVER-MAST, SWEET'S, FRASER'S.

Circle 282 on Page 19



Bethlehem circular forgings are available in carbon, alloy, and stainless steels, and some heat-resistant grades. 10 to 48-in. OD. 100 to 2,000 lb. As-rolled or rough-machined to specifications.

Which cost less, castings or circular forgings?

In initial cost, a Bethlehem circular-forged blank is competitive with a cast blank.

But that's where the competition ends.

Due to the hot working of the metal (our unique Slick Mill forges and rolls a circular product in one operation in one minute), forgings have better physical properties, greater strength than castings.

HIGHER CUTTING SPEEDS—The uniform quality of Bethlehem circular forgings allows you to use higher cutting speeds. Machining time—both in roughing, and in hobbing

teeth—is cut; tool life is increased. And there's no chance of sand damaging valuable hobbing tools.

LESS METAL — You'll find, in many cases, weight can be reduced. The greater strength of a *forged* circular product permits thinner rim sections without sacrificing strength.

Our sales engineers will be happy to give you the whole story on Bethlehem circular forgings—competitive initial cost, sure machining savings, possible weight savings, a better-quality product all around.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

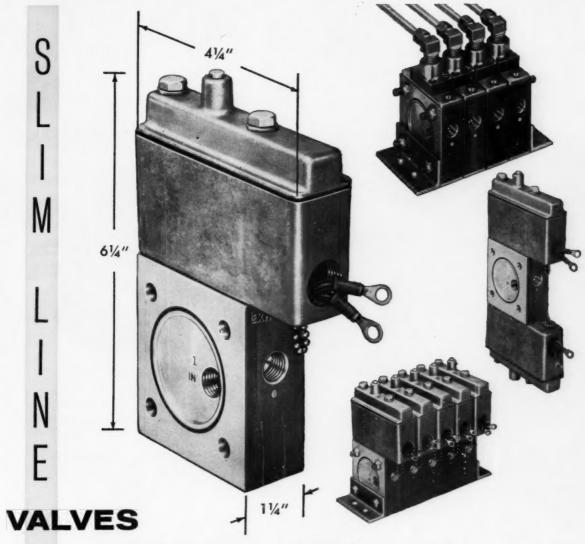
Export Sales: Bethlehem Steel Export Corporation



BETHLEHEM STEEL

Circle 283 on Page 19





- · minimum space · building block design
- · maximum control flexibility

Here's truly miniaturized, versatile precision control with surprisingly large flow capacity . . . Slim Line valves! Mount them singly to control clamping devices on jigs and fixtures. Or, bank them in manifolded groups of as many valves as you need, limited only by service and air requirements. Choose from 3- and 4-way types, for air, oil or water service, pressures to 125 psi, tapped ½ or ¼ in. NPT.

Where space is limited and you require maximum precision and versatility to control one or a virtually unlimited number of small or medium size cylinders, diaphragms, pilot cylinders, or similar devices . . . you need Slim Line valves. Ask your nearby Hunt representative for proof.

3048

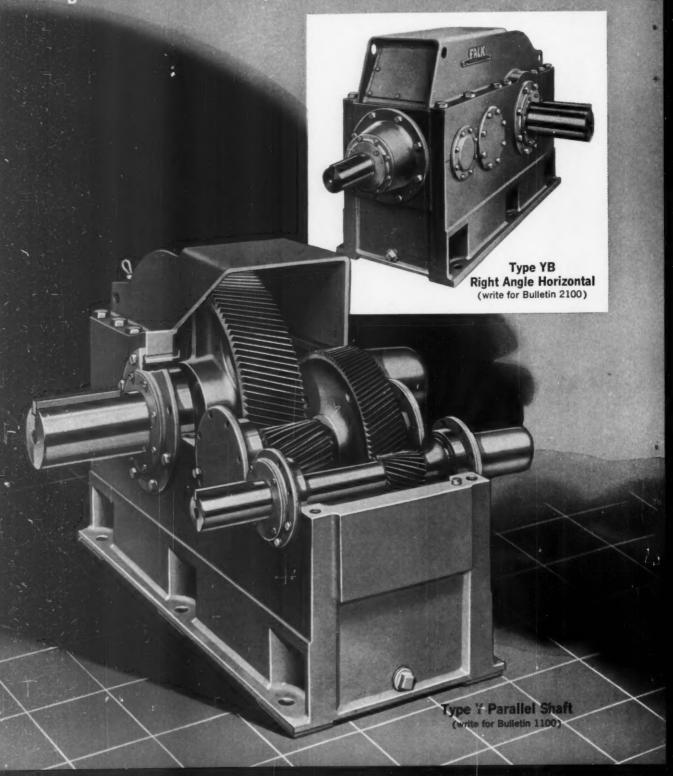
For more information, write for Bulletin 612. Address Hunt Valve Co., Salem, Ohio, Dept. MD-961.

HUNT QUICK-AS-WINK® AIR AND HYDRAULIC VALVES

MUNT VALVE COMPANY . DIVISION OF IBEC . SALEM, ONIO

FALK INTRODUCES 2 NEW SERIES OF VERSATILE SPEED REDUCERS

Designed to serve industry's current and future requirements



Parallel Shaft and Right Angle Horizontal Reducers cataloged thru 1,570,000 lb-in. torque at low speed shaft ...larger units upon request. Ratios 1.84 thru 292 to 1 for parallel shaft; 5.06 thru 1207 to 1 for right angle horizontal

These new units are probably the most thoroughly engineered speed reducers on the market today. Final designs based upon years of development study and a background of 50 years experience make these units as dependable as the name "FALK". A few of their many features are...

- PINPOINT APPLICATION COVERAGE Wide choice of sizes and ratios permits the most economical selection of a correctly rated unit for each application. In each series of parallel shaft and right angle reducers, cataloged sizes range up to 1,570,000 lb-in. torque at the (11 Inch dia.) low speed shaft. (Other standard designs to 25,000,000 lb-in. torque; custom designs for higher capacities.)
- UNMATCHED VERSATILITY The "Basic Y" speed reducer design permits economical modification to meet a multitude of specific requirements. Smooth, flat surfaces simplify mounting of motor brackets, backstops, brakes, and any number of other accessories.
- RUGGED HOUSINGS Sturdy housings not only provide maximum rigidity to maintain proper alignment of gearing, but also have the strength to support heavy overhung loads and withstand accidental blows.
- DEPENDABLE FALK GEARING Gears are selected with the proper proportions and hardness to provide the optimum combination of maximum durability and strength for high shock as well as uniform loads.
- BEARINGS TO SUIT THE OVERHUNG LOAD Standard reducers can meet custom-built requirements with optional stock bearings and shafts (at only a nominal extra charge:) Maximum overhung load capacities are so great that for some conditions, still within the capacity of the reducer, extra strong supporting foundations and bolts must be provided.
- DOUBLE GEAR LIFE Standard double ended shafts can be reversed end for end to bring into contact the unused surfaces of the gear teeth for twice the normal gear life.
- SEALS FOR ALL CONDITIONS Standard equipment oil seals assure oil-tight and dirt-free gear units for normal applications. Standard abrasive and moisture-resistant seals available upon order.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS
Representatives and Distributors in most principal cities

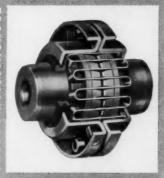
Circle 285 on Page 19



ALL-MOTOR MOTOREDUCERS



SHAFT MOUNTED DRIVES



STEELFLEX COUPLINGS

A GOOD NAME IN INDUSTRY

FALK, ALL-MOTOR, and STEELPLEX are registered trademurks

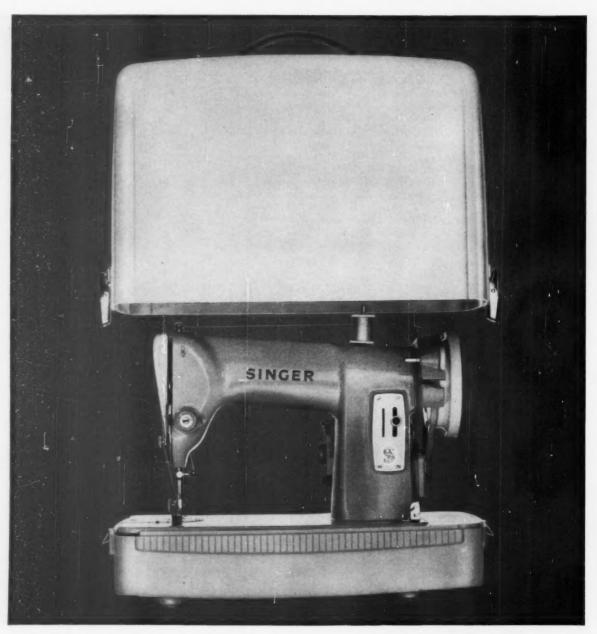


SINGER sews up a case with plastic!

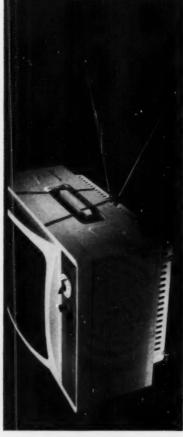
To design their new portable sewing machine case, Singer Manufacturing Company needed a tough, lightweight material. They chose a new Koppers high-impact plastic . . . DYLENE® 400 polystyrene.

The case is exceptionally strong and weighs only five pounds! It's as compact as a small piece of luggage; easy to carry, easy to store, and it's attractive.

High-impact Dylene polystyrene is strong, durable; it molds cleanly without sharp edges, eliminating costly secondary operations. It has a high surface gloss and smooth finish. Dylene can take rough handling, it won't chip or break. Dylene comes in a wide range of permanent colors.









Eight-foot giant weighs only 23 pounds

This towering store display, molded for Green Giant, is an absolute traffic-stopper. Because it's molded from lightweight DYLITE® expandable polystyrene, this 8-foot-high unit weighs only 23 pounds. DYLITE is strong, easy to mold to almost any size or contour, and easy to decorate. It's a natural for any molded part where three-dimensional detail is a must. The Green Giant was molded by Weber Plastics, Inc., Stevens Point, Wisconsin.

Plastic gives portable TV strong case against heat

Magnavox needed a high-impact, heatresistant plastic for front and back pieces
on their new 19" portables, so they chose
specially developed Koppers polystyrene
—DYLENE® 800. This easy-to-mold plastic
has exceptional strength, a heat distortion temperature of 195° F, and it meets
all Underwriters Laboratory requirements. It molds to all colors in a glossy
finish. Parts molded by Superior Plastics,
Chicago, and Alma Plastics, Alma, Mich.

New spreader made from corrosion-proof plastic

This new lightweight Seymour spreader can dispense weed killers, insecticides, fertilizers, ice melters and seed, yet it never corrodes. The hopper is molded from tough Super Dylan® high-density polyethylene. No need to worry if you drop it . . . it won't break. This spreader won't leak or absorb odors, and it's easy to keep clean. Spreader molded by Amos Molded Plastics, Edinburg, Ind. for Seymour Mfg. Co., Seymour, Indiana.

KOPPERS PLASTICS

Learn how Koppers family of fine plastics can improve your product at less cost. Contact Koppers Company, Inc., Plastics Division, Dept. 126, Pittsburgh 19, Pa.





If gears rotated the world...

CINCINNATI

CUSTOM GEARS AND GEAR BOXES

assure this kind of dependability. They are precision made, guaranteed to meet your specifications exactly!

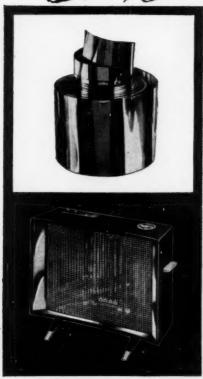
Ask for this brochure—CINCINNATI custom gears are made in all types to 72" diameter cut teeth, 39" shaved teeth, 25" ground teeth.

better still . . . Send us your prints for quotation



THE CINCINNATI GEAR CO.

Cincinnati 27, Ohio Custom Gear Makers Since 1907 GEARS, good gears only



HEATER

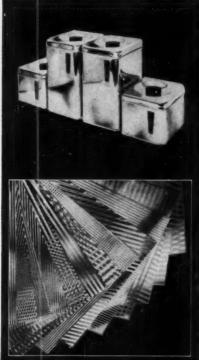
Designer's Paradise

Here are exciting design materials . . . fascinating and versatile. Nickeloid Metals are eager and willing servants in the hands of the expressive and resourceful stylist. Their potentialities are as unlimited as the boundless imagination of the mind itself. The effects that can be created are immensely varied, so very flexible — giving you wide choices in luster, color, texture, patterns. The styling can be lavish or restrained; cool or warm; shimmering or satiny; soft or flashing. New vistas await exploration by the inventive, whether the use be decorative, structural, or for styling detail. Always, Nickeloid Metals are ductile, durable, workable, practical.

NICKELOID ...THE METAL WITH THE BRIGHT OUTLOOK

A modern metal, a metal for the times . . . functional, beautiful. At home always with high styling; equally responsive when called upon to serve in rough-and-tumble utilitarian and structural assignments. Nickeloid Metals brighten the profit outlook with plenty of eye-appeal and sales-appeal. You can choose from: glinty hard, mirror-like Chromium — soft, mellow, richlooking Nickel — glowingly warm Copper — radiant, gold-like polished Brass. Nickeloid Metals add a shimmering luster to thousands of products used in home, in office, in commerce. These sheets and coils are pre-finished, ready for mass production.







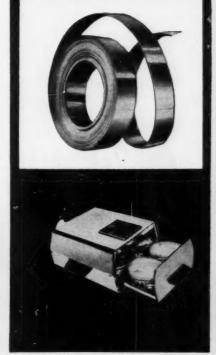


TABLE BROILER

Details Sent Free

All who design, style, or manufacture will want to learn more about these versatile metals . . . will want to build a file of product information on the materials comprising the Nickeloid family of pre-finished metals. The data will include specifications and fabrication information. Metal samples for inspection are supplied for your file. Larger working samples for testing or for mockups will be supplied when details of the proposed use are furnished. A sales engineer will be glad to show you exciting new applications, to discuss metallurgical or fabrication problems, to help you develop cost comparisons. A letter will bring complete details.



AMERICAN NICKELOID COMPANY

America's Pioneer Manufacturer of Pre-Finished Metals — Since 1898
Peru 8, Illinois — MILLS: Peru, Ill. and Walnutport, Pa.

SALES OFFICES in Chicago, New York, Cleveland, Buffalo, Los Angeles, St. Louis, Chattanooga, Boston, Philadelphia, Dallas, Salt Lake City, Seattle, Toronto. See the yellow pages of your telephone directory.



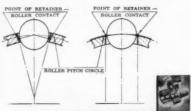
cGIL

INCREASE EXPECTED LIFE UP TO 10 TIMES!

You need CAGEROL bearing performance if higher speeds and increased misalignment have prevented the utilization of needle bearing load capacity in your applications. Most important, CAGEROL bearings can deliver up to 10 times more expected life where misalignment and increased speeds exceed the capabilities of ordinary and guided needle bearings. The difference is in the exclusive McGill construction that features tapered retainer pockets for balanced roller guidance, crowned rollers, and black oxide retainer finish. CAGEROL bearings are interchangeable with all heavy duty needle roller bearings - with or without inners in two bore sizes.

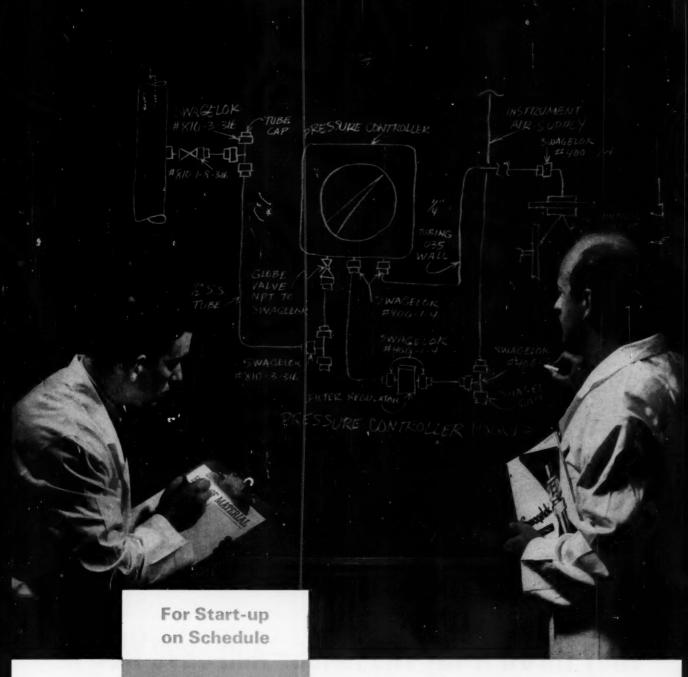
> McGILL MANUFACTURING CO., INC., Bearing Division 200 N. Lafayette Street, Valparaiso, Indiana

- Exclusive crowned roller construction, electronically gauged to insure precision contour and size uniformity. Relieved ends assure even load distribution. load distribution.
- 2 Flat ends fully engage integral race shoulders. provide maximum support.
- 3 Proper guidance assured by tapered retainer pockets. The design insures balanced roller support and eliminates corner wear from edge loading of straight pockets where retainer OD and pitch circle are coincident.
- 4 Simultaneously punched pockets assure accuracy of race and roller alignment. The black ferrous oxide retainer finish absorbs and retains lubrication, reducing the friction coefficient.
- SAE 52100 steel outer race has optimum hard-ness and surface finish.



Ask for Bearing Catalog #52-A

engineered electrical products precision needle roller bearings





Don't Let Leaky Connections Cause Expensive Delay at Start-up

These engineers are specifying Swall for plant construction. The most severe test of tube fitting design and quality is in plant construction. Many plants have been built using 10,000 to 20,000 or more Swall tube connections without a leak. You can spend days to find one leak among the thousands of tube connections on a construction job.

Insure plant start-up on schedule—specify Swall for plant start-up on schedule for plant sta

CRAWFORD FITTING COMPANY, 884 East 140th St., Cleveland 10, Obio CRAWFORD FITTINGS (Canada) LTD., Niagara Falls, Ontario, Canada



Standard Forge & Axle Co. forges 5-inch by $\frac{1}{2}$ -inch Pittsburgh Seamless Mechanical Tube ends down to $2\frac{5}{6}$ " solid steel wheel spindle ends (cross section above). The Montgomery, Ala.,

plant then machines and grinds bearing surfaces to .0005-inch tolerance to produce single-piece, 20,000 pound capacity trailer axles. Trailer operators benefit from higher payloads because . . .

They Throw Away The Holes—And Save Weight

The trick in making a seamless steel tube is piercing a hole in a round of solid steel.

But Pittsburgh Steel Company's Seamless Steel Mechanical Tubing makes the full circle in production of trailer axles at Standard Forge & Axle Co., Montgomery, Ala.

Standard, in effect, throws away the holes by forging the tube ends down to solid steel again, leaving only a hollow steel center and spindle section.

The result: a lightweight, one-piece trailer axle made entirely from a single length of seamless tube—including load bearing wheel spindles, precision ground for bearing and seal seats.

The advantage: assured strength and safety of seamless steel, plus, for example, reduced axle weight for trailer operators in a 20,000 pound capacity axle.

Starting with a seamless steel tube 5" x ½" x 87%" for this particular axle, Standard upsets both ends, then swages them down to the shape of a spindle with a 25%" solid end.

That's deformation of the rough-

But Pittsburgh Seamless Mechan-

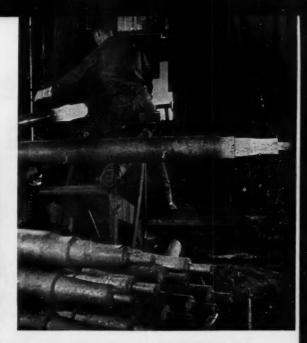
ical Tubing takes it in stride, then bounces back under heat treatment with the physical properties required for precision finishing of the critical spindle surfaces, and the toughness necessary for a long life in hard service

And that kind of performance takes seamless steel tubes with exceptional internal soundness, consistent grain structure, and chemical and dimensional uniformity.

Pittsburgh C-1040 grade Seamless Mechanical Tubing supplies these properties consistently—for this type After upset, Pittsburgh Seamless Mechanical Tubes, with 5-inch OD and ½-inch wall, are swaged to solid steel spindle shape on drop forge, at right. Standard's heat treating process refines grain, restores toughness of steel.



Standard also produces high-strength inserted spindle trailer axle by inserting forged alloy steel spindle with 4.065-inch OD into 4.040-inch burnished ID of 5-inch seamless steel tube under 50,000-pounds pressure.





Standard Forge & Axle Sales Manager James A. Rumbley says Pittsburgh Steel Company, as longtime major supplier of seamless mechanical tubes, "leaves nothing to be desired in product or service."

axle and for Standard's high-strength inserted spindle type.

James A. Rumbley, Standard's sales manager, says:

"Trailer axles are high-weight carrying members subject to tremendous load shocks. So we use the finest materials available to assure our customers trouble-free service. Seamless steel mechanical tubes help us to do that, with complete safety and at less weight.

"For many years, Pittsburgh Steel Company has been one of our major tubing suppliers. It has left nothing to be desired either in product or service."

That's standard practice with Pittsburgh Steel—whether supplying seamless mechanical tubing to Standard's specific requirements, or to yours. Be certain with Pittsburgh Seamless. Contact one of the district offices listed below.

Pittsburgh Steel Company



Grant Building

Pittsburgh 30, Pa.

DISTRICT SALES OFFICES

Atlanta Cleveland
Chicago Dallas

Dayton Detroit Houston Los Angeles Pittsburgh New York Tulsa Philadelphia Warren, Ohio



Circle 290 on Page 19

The TUTHILL Internal Gear Pump...and its advantages in reversing applications

by E. H. Schanzlin, Chief Engr., Tuthill Pump Co.

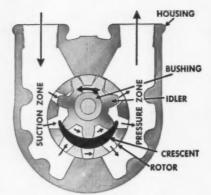
Extremely high reliability, proven in thousands of applications over a 30 year period, has made Tuthill's internal gear pump an industry standard. The Internal gear construction particularly adapts itself to reversing pump applications as indicated in the sketches at right.

How It Operates

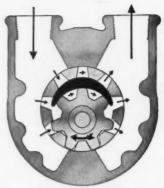
Key elements are the rotor, idler gear and the crescent shaped partition. This crescent shaped partition, shown in heavy black, is cast integral with a moving part called the idler carrier.

In the drawing at left, power is applied in counterclockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

When shaft rotation is changed from counterclockwise to clockwise, as in the drawing at right above, the idler carrier, (including the idler gear and crescent) automatically rotates 180° through the suction zone. This changes the directional flow within the pump without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that



COUNTERCLOCKWISE ROTATION



CLOCKWISE ROTATION

the crescent can rotate only 180°—always through the suction zone. If rotation were again reversed to counterclockwise, the crescent would swing back to its original position (shown at left above).

No valves required . . . ports remain constant

This unique construction permits positive reversing action, without any valves, and with the port positions remaining constant. In addition Tuthill's reversing pumps provide all the other attributes of internal gear construction . . . extremely high reliability, compactness, and high efficiency.

Reversing Pumps with internal gear construction pay particular dividends on applications where the pump must be driven from a reversing shaft or when machinery must be shipped without knowing the ultimate direction of the driving unit.

375 reversing pump models

Tuthill offers a complete selection of over 800 different pumps including 375 different reversing pump models for capacities from ½ to 200 GPM; for pressures to 400 PSI; and speeds to 1800 RPM. These include a complete selection of stripped models for incorporation into products. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill's engineers to meet the requirements of specific applications.

Catalog 105 contains complete information on all Tuthill Reversing Pumps. Write today for your copy.



Typical Tuthill Reversing Pump. Model 2RC has capacity of 5 GPM operating at 100 PSI, 1200 RPM.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.



TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois





DIAMOND

cracks DESIGN BARRIERS

New horsepower ratings* for Diamond Roller Chains, plus four new products, have opened up a whole new range of Diamond Roller Chain applications for design engineers!

Size for size, Diamond now gives you increased horsepower capacity, higher speeds, longer life, and greater economy in present applications . . . and suggests many new areas in which roller chain efficiency can be utilized.

Example: Former ratings for 1" pitch roller chains permitted sprocket speeds up to 1160 RPM; new ratings include speeds to 2800 RPM. Rated horsepower capacities formerly did not exceed 49 HP; new ratings exceed 150 HP.*

*New speed and horsepower ratings are those established by the Association of Roller and Silent Chain manufacturers, of which DIAMOND is a charter member.

See next page for Diamond's four new product developments which may help you solve present special problems.

Available now—new DIAMOND Stock Roller Chain, Sprocket and Coupling Catalog No. 760 with new higher ratings for roller chains.

DIAMOND CHAIN COMPANY, INC.

A Subsidiary of American Steel Foundries
402 Kentucky Avenue • Indianapolis 7, Indiana





ROLLER

World's smallest bushing type chain!

Actual Size .1475" PITCH .035 Lb./Ft.

Tensile Strength: 180 Lbs.

For cameras, computers, recorders and other devices with miniaturized movements requiring strength, synchronization, and precision. Precision built of corrosion resistant, non-magnetic stainless steel. Stock sprockets available . . . or made to your specifications. Conveyor chain supplied with special attachments on custom orders.

For additional information, request free Bulletin

REGISTERED IN UNITED STATES PATENT OFFICE

These new products can help solve your design problems



All working parts are heat treated steel, hardened to give greater resistance to wear and longer service life. Hi-Cap Couplings can be quickly installed, aligned and connected without special tools. A single pin easily connects the coupling chain. Removal of chain completely disengages the driving and driven units. Available in Finished Bore and Taper Lock.

Request free Bulletin

The trademark Hi-Cap is the property of Diamond Chain Company, Inc.



Diamond "Projection welds" produce a permanent metal fusion as strong as the metal itself.

Duraweld eliminates rivets, attachments and extra fittings. Duraweld is easily detachable at any joint. Links are interchangeable with links of other roller chains of the same general type and may be used on existing rails.

Request free Bulletin

DIAMOND CHAIN COMPANY, INC. A Subsidiary of American Steel Foundries

A Subsidiary of American Steel Foundries
402 KENTUCKY AVENUE • INDIANAPOLIS 7, INDIANA

Offices and Distributors in All Principal Cities



Request free Bulletin

pitch, or equivalent offset side bar chains.

connection; may be used over existing sprockets cut for American standard roller chains of same

The trademark Tuf-Flex is the property of Diamond Chain Company, Inc.



September 14, 1961



Gold in Them Thar Hills?

ORE than half of the engineers working for industry in this country earn over \$9600 a year, according to the 1960 income survey by the Engineers Joint Council. For members of the National Society of Professional Engineers, surveyed about the same time, the corresponding figure is slightly over \$10,000.

The median \$10,000-a-year man in the NSPE survey has been out of college about ten years. But the upper ten per cent of engineers have reached that figure within four years of graduation, and the upper twenty-five per cent within six years. On the other hand, it took the lower twenty-five per cent nineteen years to get there, and the lower ten per cent never made it.

After ten years the upper ten per cent of engineers are making over \$14,000 a year. But after twenty years this upper tenth group is over \$20,000 while the median, or man in the middle, has reached only \$12,000.

The upper salary brackets, of course, are heavily populated by engineers who have become managers or who have gone into business for themselves. How do these groups look when separated from the "working" engineers?

Half of the engineers in executive-administrative work are making more than \$13,000, according to NSPE. The upper tenth of this group makes over \$26,000. Further separation of those in the highest-level engineering executive jobs (NSPE Professional Grade 8) reveals that half of those VIP's make over \$22,000 a year, and ten per cent make over \$47,000.

Self-employed engineers do quite well, too. Half of those "own boss" types make over \$15,000 and ten per cent over \$34,000.

Somebody has said that a statistic is simply a number with a chip on its shoulder. It has also been said that figures can't lie but liars can figure. So it is necessary to beware of drawing sweeping conclusions from such data. However, it seems safe to say that engineers today have little cause to complain that their profession fails to offer opportunities for satisfactory, if not lavish, monetary rewards.

Of one thing we can be reasonably sure. Those in the upper brackets didn't get there by waiting for somebody else to pull them up—any more than the forty-niner waited for the gold nuggets to jump into his pocket.

bolin barmilael

How to set up and co-ordinate a

Statistical Dimensioning Program

K. A. BROOKS

Endicott Development Laboratory General Products Div. International Business Machines Corp. Endicott, N. Y.

Although the concept of statistical dimensioning was suggested over thirty years ago, few assemblies actually required this approach in the early thirties. Times change. Today, the mass production of some types of critically dimensioned assemblies cannot be economically produced any other way. However, setting up a statistical dimensioning program is something more than the simple application of the laws of probability. It requires a closely co-ordinated program to make it function properly. Presented here is a guide to setting up such a program.

THE technique of statistical dimensioning permits both designer and manufacturer more leeway with critically toleranced parts. It is most appropriate when parts are produced in quantity, when they must meet restrictive dimensional requirements, and when they are mated with other parts in an assembly which also has restrictive dimensional requirements.

Statistical dimensioning improves the way assemblies function, while allowing all the dimensional tolerance possible for critical components. This pro-

cedure has made possible economical production of designs that are virtually impractical under the conventional limit tolerance method.

Statistical dimensioning results in three significant benefits:

- Higher quality design through better fits and clearances.
- Lower manufacturing cost through wider part tolerances.
- 3. Less scrap and rework through use of process controls.

Basic Considerations

Under the conventional limit tolerance system, it is assumed that parts having dimensions on the extremes of the tolerance will be assembled with other parts with dimensions also at the extreme of the tolerance—at least some, or possibly all, of the time. Thus, component tolerances are assigned so that when all parts of an assembly have dimensions at the limit of the tolerances—giving the "worst" possible conditions—the assembly still performs satisfactorily.

Overly cautious, say the statisticians. If the parts are mass produced and assembled in a random way—that is without selecting each part for size—it is highly unlikely that all the parts assembled into any

given group will actually be formed so the dimensions are all at one extreme of the tolerance limit.

The total tolerance of an assembly will probably be considerably less than the sum of the individual tolerances—only half the sum if there are four parts involved. This is the heart of the statistician's argument. To predict the total tolerance, take the square root of the sum of the square of the individual tolerances, rather than the sum of the tolerances

In practice, the assembly tolerance requirement determines the individual tolerances allowed each part. Using the statistical technique described in Table 1, larger tolerances can be assigned to each part than under the more conventional procedure. Tables 2 and 3 show some practical examples.

For example, in a two-component assembly, 70 per cent of the assembly variation can be assigned to each of the components. In a four-dimension assembly, 50 per cent of the assembly tolerance can be assigned to each of the components—increasing the tolerance by 100 per cent over limit dimensioning. In a ten-dimension assembly, 30 per cent of the allowed assembly variation can be assigned to each component—an increase of 200 per cent. IBM is using the statistical procedure for a 60-piece assembly in which 13 per cent of the assembly tol-

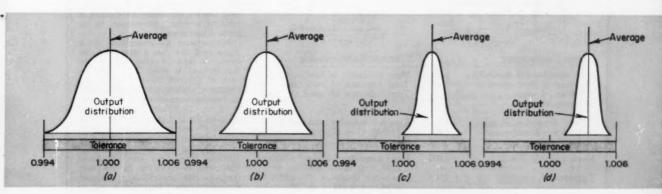


Fig. 1—Process control output curves when, a, variation is equal to design tolerance; b, variation is somewhat less than design tolerance; c, variation is considerably less than design tolerance; and d, variation is at the extreme of design tolerance.

Table 1—Basic Statistical Tolerancing

Under conventional limit dimensioning, individual tolerances are added to give assembly tolerance, Fig. 1-1. By

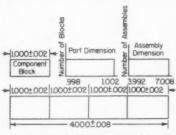


Fig. 1-1—Limit dimensioning of fourblock assembly. Each block has a tolerance of ±0.002 in., and squareness is ignored for simplicity.

changing to statistical dimensioning procedure, two tolerancing possibilities exist:

- Retain tolerances for individual parts and reduce total assembly tolerance.
- Accept total assembly tolerance and increase tolerance for each part.

An example of each possibility is shown in Fig. 1-2.

If the four-block assembly must fit into a space that has an economical tolerance of ±0.005 with a 0.001 in. minimum clearance, Table 1-1, under limit dimensioning the maximum clearance would be 0.027. However, under statistical dimensioning, the maximum clearance would be only 0.0138 in., or about half the clearance

under limit dimensioning. It is obvious which would give the better fit.

fit.

If the assembly has been performing satisfactorily on a limit basis, then the approach becomes: "What tolerance can be assigned to the components while maintaining the same clearance?" If the total variation is 0.027 - 0.001 = 0.026, and the space tolerance remains at ± 0.005 , then $0.026 = [4(X)^2 + (0.010)^2]^{\frac{1}{2}}$ and X = 0.012 or ± 0.006 .

To maintain the same quality in the

To maintain the same quality in the assembly as with limit dimensioning, the tolerance on the parts would be increased from ±0.002 to ±0.006 in a statistical dimension design.

This procedure assumes a distribution of dimensions about an average, and since the controls employed serve to maintain this distribution, it is important to understand the ideal distribution and of how to maintain it.

The distribution desired is the classic "normal distribution." A very wide curve shows a variation that is often too great. A narrow curve shows a variation that may be very difficult to attain in actual production.

A standard deviation (σ) , which is a measure of curve width, is defined as the root-mean-square deviation of the observed values from their average. If X_1 , X_2 , X_3 , represent the observed values and \overline{X} their average, then:

$$\sigma = \left[\frac{(X_1 - \overline{X})^2 + (X_2 - \overline{X}_1)^2}{n} \right]^{\frac{1}{2}} + \left[\frac{\dots + (X_n - \overline{X})^2}{n} \right]^{\frac{1}{2}}$$

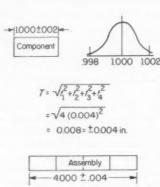
From this equation it is obvious that every distribution has its own standard deviation. One standard deviation always includes 34 per cent of the values in each direction from the average. But it is usually referred to as "plus or minus one standard deviation," and this always includes 68 per cent of the values in the distribution. Within $\pm 2\sigma$ of the average always includes 95.5 per cent of the values and within $\pm 3\sigma$ of the average will always be 99.73 per cent of the values.

The standard deviation becomes useful—since it is a measure of probability—in finding out what the chances of selecting average, near-average, or extreme dimensions.

For instance, the chances of selecting a part that has a dimension between 2σ and 3σ (the tails of the distribution) is about 2 per cent for each of the two areas. Further, the chances of picking two consecutive parts at random from either of these areas is 4 in 10,000—the probability of selecting the first piece times the probability of selecting the second piece.

The more parts that make up an assembly, the less the probability of selecting more than one component that will have values in the tails. And, as this probability is lessened, the greater the tolerance that can be assigned to each component of the assembly.





Retaining Total Assembly Tolerance

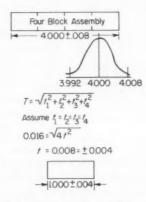
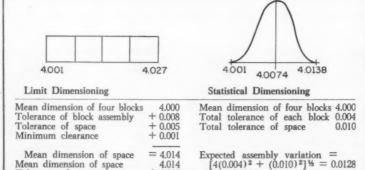


Fig. 1-2—Statistical dimensioning of four-block assembly by retaining individual block tolerances, or retaining total assembly tolerance, in.; t=individual component tolerance, in.

Table 1-1—Comparative Analysis of Limit Versus
Statistical Dimensioning



+0.005

-4.000

+0.008

0.027

or ± 0.0064

 $\begin{array}{ll} \text{Mean dimension for space} &= 4.000 \ + \\ 0.001 \ + 0.0064 \ = 4.0074 \\ \text{Maximum clearance} &= 4.0074 \ + \\ 0.0064 \ - 4.000 \ = 0.0138 \end{array}$

Tolerance of space

Mean assembly dim.

Tolerance of assembly

Maximum clearance

erance is assigned to each component—increasing the tolerances over what limit dimensioning would allow by 700 per cent.

Statistical Analysis and Process Control

All this is fine. But it won't work unless parts are made so that each dimension for a batch of parts forms a near bell-shaped curve reflecting a normal distribution. Therefore, the heart of success lies in the use of statistical analysis and process control. This involves setting up the process so that the output conforms generally to a bell-shaped curve. It involves, too, a procedure that makes sure the output stays within this curve, and the average of the output is close to the mean print dimension.

Some graphic examples show how the output of any control process might look. For simplicity, the mean dimension is 1.000 in, with a tolerance of \pm 0.006 in.

Example 1: Normal variation in process output is equal to the variation or tolerance allowed by the design, Fig 1a. A distribution with a variation that utilizes this full tolerance is completely satisfactory for the purpose of statistical dimensioning. From a practical manufacturing standpoint, however, such a situation might not be satisfactory because there is no allowance for drift of the process due to tool wear or variation in material. Also, each setup must be exactly on the mean dimension to avoid producing parts outside of tolerance.

Example 2: Normal variation in process output is somewhat less than the variation or tolerance allowed by the design, Fig. 1b. A distribution with

this type of process picture is completely satisfactory for the statistical dimension technique, and also practical from a manufacturing standpoint. There is sufficient allowance for drift of the process, slightly different setups, etc. As a general rule, it is recommended that the normal variation of the process be no greater than 75 to 80 per cent of the part tolerance. Allowance, however, may be greater for a stable process or less for a relatively unstable process.

Example 3: Normal variation in process output is considerably less than allowable tolerance, Fig. 1c. Again, a distribution with this type of process picture is satisfactory for both the statistical dimension technique and manufacturing. But it becomes important with this kind of picture that the process be controlled toward the middle of the tolerance so that the condition in Fig. 1d does not occur.

The process picture in Fig. 1d is unsatisfactory for statistical dimensioning techniques because of the high concentration of parts at the extreme of the tolerance. Since most of the parts are located in the "interference area" they will not assemble properly; that is, the probability of selecting successive parts from the tail is dangerously high.

It should be pointed out, however, that the process picture shown in Fig. 1c is quite uncommon for statistical dimensioning. For economic reasons, parts are usually produced by the least expensive method that can maintain the tolerance and still benefit from the allowable variation.

Co-ordinating the Process

In practice the designer will confer with manufacturing engineers on production methods to be

Table 2—Permissive-Make Relay

A relay—known as the "permissivemake relay"—is the first complete assembly produced by IBM in quantity through the probability concept of tolerance accumulation. IBM has assembled more than one million of these relays and over 95 per cent of them have met performance specifi-

cations without adjustment.

Significant is the fact that initial analysis of the device indicated that it could not be produced economically under the restrictions of limit dimensioning.

Gaps and clearances at the contacts, Fig. 2-1, are the critical mechanical areas. To obtain the speed desired the normally open gap should average 0.012 in. and the normally closed gap 0.011 in. with a minimum of 0.002 in. for the clearances, Table 2-1. Nine dimensions have tolerances which influence the workability of the normally open gap in the relay, Table 2-2.

Tolerances were computed on a probability basis, giving a total of 0.0058 in. variation, while the arithmetic sum of these same tolerances would have been 0.016 in., or nearly three times the acceptable variation.

Table 2-1—Tolerances for P-M Relay

	Gap	Statistical Tol.	Limit Tol.	Clearance	Statistical Tol.	Limit Tol.	
Normally open	0.012	+0.0029	+0.008	0.005	+0.0021	+0.005	
Normally closed	0.011	± 0.0021	± 0.005	0.006	± 0.0029	±0.008	

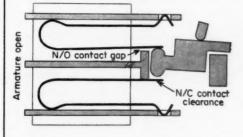


Fig. 2-1 — Permissivemake-relay contact sys-

Table 2-2—Tolerance Analysis of Gap Variation

Component Dimension	Tolerances (in.)
Actuator backstop	. 0.003
Actuator wire lifter	
Wire lifter parallelism	. 0.001
Base pad flatness and parallelism	n 0.001
Yoke thickness	. 0.002
Yoke flatness	. 0.002
Armature flatness	
Contact alignment	
Contact wire alignment Total gap variation	. 0.002
(statistically dimensioned)	0.0058
(if limit dimensioned)	. 0.016

employed. Their mutual aim is to specify the most economical method of producing the required dimensions. The designer can help by rearranging the tolerances of the various parts to suit the processes as long as the statistical accumulation of tolerances will meet functional requirements; the square root of the sum of the square of the tolerances must be equal to or less than the required assembly tolerance. At the same time, the designer must remind manufacturing that a "normal distribution" with an average close to the mean dimension is absolutely necessary.

Everyone connected with statistical dimensioning must recognize specific responsibilities. Engineering must understand the basic application techniques described, and also the necessity for producing parts to the required distribution. In addition, they must identify the dimensions on the drawing (at IBM this is accomplished with the note: "Statistical Dimension").

Manufacturing engineering must design tools to produce parts around a mean dimension as required by the print specification. They must also provide proper identification of operations producing controlled dimensions.

Quality control must set up the necessary controls on every job, and consult with manufacturing engineering to provide the adequate inspection equipment. They also assist manufacturing in setting controls, audit the lot by a final inspection on the controlled dimension, and determine process capability information obtained from the controlled processes.

Manufacturing Problems

Manufacturing must produce the controlled dimensions following the instructions for manufacturing and inspection as established for the process.

Manufacturing encounters three stumbling blocks in trying to deliver this normal distribution close to the mean dimension. They are:

- 1. Providing proper tool adjustment for process control.
- 2. Insufficient knowledge of process capabilities under

Table 3—Pivot-Stud Assembly

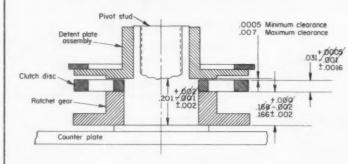


Fig. 3-1—Pivot-stud assembly.

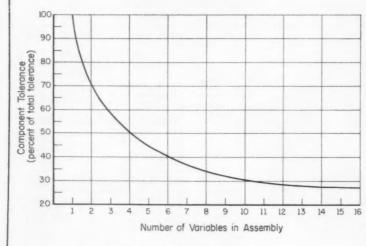


Fig. 3-2-Component tolerance chart.

In a pivot-stud assembly in a ratchet counter, the clutch disc and the ratchet gear must rotate freely, Fig. 3-1. The sum of their thickness dimensions must be less than the height of the pivot stud shoulder. The accumulation of the dimensions and tolerances results in a minimum clearance of 0.0005 and a maximum of 0.007 in. The variation in the assembly clearance is 0.007 - 0.0005 = 0.0065 in.

The ratchet gear was changed from a three-piece assembly to a sintered metal part. It was not possible to hold the 0.002 total tolerance on the 0.168 dimension of the sintered metal part, necessitating an additional operation.

The variation in the assembly is 0.0065 with an average of 0.00375. Using print dimensions on the pivot stud and clutch disc, the ratchet gear dimension is: 0.201 — (0.00375 + 0.031) = 0.16625, which rounds to 0.166 in. Average clearance in the assembly is 0.201 — (0.031 + 0.166) = 0.004.

For three component dimensions, Fig. 3-2, approximately 60 per cent of the assembly variation can be assigned to each component. Thus, 0.0065 (0.6) = 0.0039 in. total talerance for each part. Since nearly 0.004 can be used for each of these components, ±0.002 is applied to the 0.166 and 0.201 dimensions, and the remaining allowable tolerance for the 0.031 dimension is calculated thus:

$$0.0065 = [2(0.004)^2 + t^2]^{\frac{1}{2}}$$

$$t = 0.0032 \text{ or } \pm 0.0016$$

The increased tolerances eliminated the grinding operation necessary to hold the tolerances on both the ratchet gear and clutch disc thickness. In the final analysis of the assembly, the tolerance on the 0.031 dimension was changed to ± 0.002 . The assembly clearance is then 0.004 \pm 0.0035.

Table 4—Four Quality Control Techniques

 $\overline{\mathbf{X}}$ -R Charts, $\overline{\mathbf{X}}=$ dimension average of samples, R= range of dimension variation in samples. This is the oldest process control technique. It requires the operator to sample production and set up high and low control limits on sample average and range. A sample could comprise five consecutive parts, but varies with circumstances. Periodic samples are checked against control limits established. Operation stops for adjustment if a control limit is exceeded. Requires considerable operator training and computation.

Median Chart. Similar to the \overline{X} -R charts. Control limits on dimensions are set up by quality control department on charts. Operator takes sam-

ples at intervals, measures them and marks actual dimensions on chart. He circles median dimension, uses it as his indicator of product quality. As with \overline{X} -R charts exceeding control limits requires operation adjustment. However, less operator training is required and no operator computation is necessary.

Audit Inspection. This technique is normally employed after production but it can be used in lieu of other techniques for production where the operator has little or no control or influence on quality—that is when the process is very stable. It consists of random sampling and inspection of parts after production. Quality of entire run is judged on the appearance of the samples.

Quality Precontrol. This technique was developed by Rath & Strong Inc., and Jones & Lamson Machine Co. It is the control technique favored by IBM Endicott. The technique uses control points somewhat narrower than the tolerance spread, though they do not reduce the tolerance or allowable variation. The technique fits well into IBM's present practice of operator inspection and does not require the operator to calculate averages or ranges. In most cases plotting is not necessary. Precontrol utilizes go-no go gaging (attributes) as well as variable (direct read) gaging. There are several precontrol plans and which one to use depends on the process picture width and the quality level desired.

process control.

Subsequent operations that affect controlled dimensions.

With a fixed tool setup, some difficulty has been experienced in determining tool dimensions that produce a near normal distribution with the mean near the print mean. This is particularly true for sintered metal, plastic molding, and punch and die tools. However by building good quality tools and establishing the process variation on the pilot order, these processes can be successfully controlled.

Tool wear is a problem with certain processes. Working with dies in a press is a good example. Under limit dimensioning, manufacturing fixes the dies to start producing dimensions concentrated at one limit. The press is then run until the dimension of the output begins to hit the other limit. For relatively small lots of parts this is unsatisfactory because of the concentration of dimensions at the extremes of tolerances. Instead, it is best to start about halfway between the mean dimension and one extreme, then run until a steady stream of parts is produced with dimensions halfway between the mean and the other extreme. This produces a distribution sufficiently close to normal to be satisfactory. And number of parts that can be run (since statistical tolerances are wider than limit tolerances) is rarely affected.

The second problem area in applying statistical dimensioning is due to the ever-changing nature of process capability. Process capability is the variation a machine can economically maintain over a number of different setups. It has been proved that when statistical process controls are used, the actual process variation is much less than anticipated by machine operators. With the aid of process control, a machine will hold tolerances that previously were considered out of the question.

Subsequent operations in processing cause additional problems. For instance, a part may be cut on a broach and then heat treated. Or, a part may be roughed, milled and then locally hardened. Effects of the heat treatment will cause the mean

dimensions to shift and the spread of the distribution to increase. Often it is necessary to start by cutting the part so that it is out of tolerance and then allowing the heat treating to pull it into tolerance limits. Again, the most satisfactory method of determining how this is to be done is to run one or more pilot orders.

Quality Control

Statistical dimensioning requires process controls to make it work. Quality control can select from many generally accepted techniques for inspection and control. The four most common procedures are described briefly in Table 4.

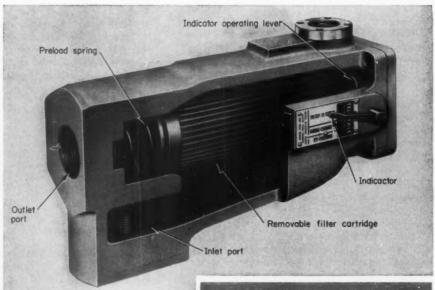
Implementation

Now, what about setting up a statistical dimensioning procedure? At IBM, a committee was established. It consisted of representatives from engineering, manufacturing engineering, quality control, and manufacturing. The committee's basic function was to prepare material and instruction for the educational program necessary to make statistical dimensioning succeed. In addition, the committee co-ordinated the efforts of the various areas in adopting the program, and also acted as a control group.

Data and experience accumulated on different applications were compiled and passed on to interested groups. A booklet was written to promote better understanding of statistical dimensioning by manufacturing engineers and by IBM suppliers. Another booklet was prepared on quality precontrol to assist the department manager in instructing the operators in the use of process control. In addition, a wallet-size card was prepared for the operator with the basic steps of quality precontrol.

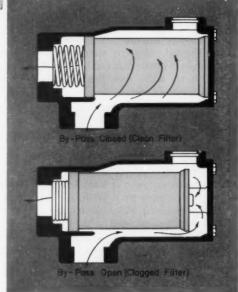
A corporate standard written by the committee serves to assist the designer in the application of statistical dimensioning.

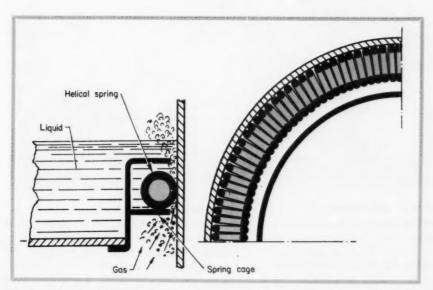
scanning the field for ideas



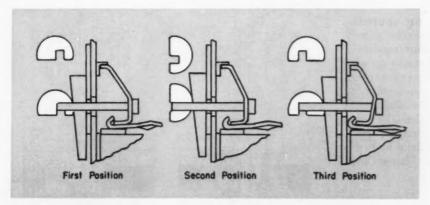
Filter moves indicator

to show when the filter element needs cleaning. As the element becomes clogged in operation, increased pressure drop causes the element to compress the preload spring. Position of the filter element is indicated by an external pointer. Principle employed in a filter of the Rosaen Co., Hazel Park, Mich., distributed by Vickers Inc., Detroit, Mich.



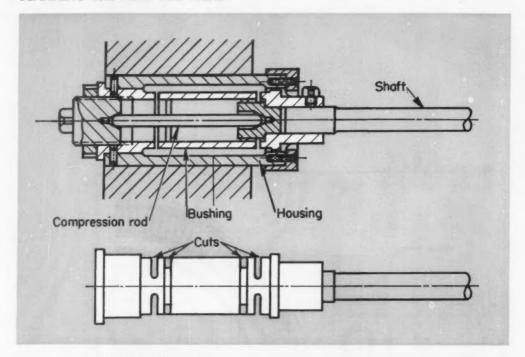


Spring holds liquid but permits passage of gas. Spaces between the coils of the helical garter spring, installed between the plate and the wall of a distillation column, are so small that surface tension of the liquid prevents its passage. However, the lower surface tension of the gas permits it to pass through the spring spaces. Principle employed in a column by Julius Montz, Hilden, Germany.



Position controls size of a semicircular adjusting shim. Eccentric mounting slot permits the shim to provide three effective lengths. Principle employed in a tensioning device by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

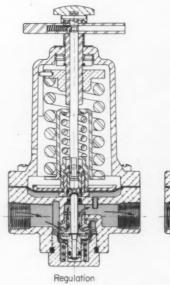
SCANNING THE FIELD FOR IDEAS

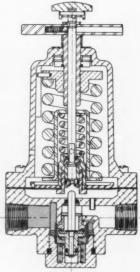


Flexures permit misalignment but provide torsional and axial rigidity. Two flexures in the bushing, each formed by two cuts perpendicular to each other, allow both angular and parallel misalignment of the shaft sup-

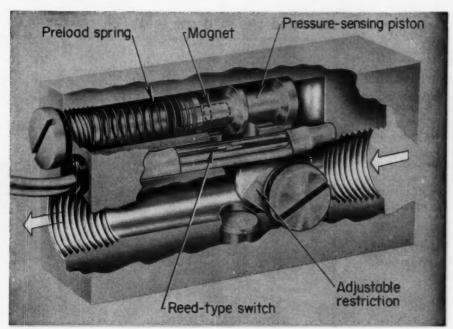
ported by the bushing. Torsional rigidity is inherent in the flexures and axial rigidity is provided by a compression rod inside the bushing. Principle employed in a lathe by Alfred H. Schuette, Cologne, Germany.

Regulation or shutoff is provided by the same poppet valve in a pressure regulator. Position of a manually-actuated push - rod determines whether the poppet valve is controlled by the diaphragm or is free to be closed by inlet line pressure. Principle employed in a regulator by Benbow Mfg. Corp., Culver City, Calif.



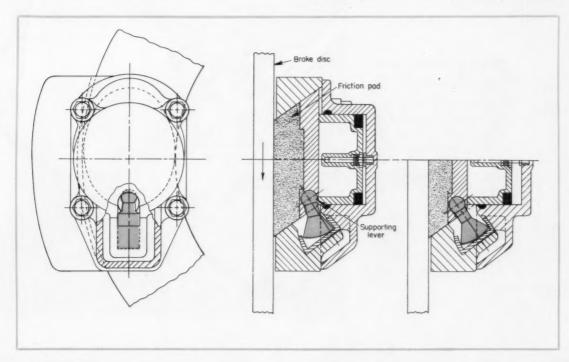


Shutoff



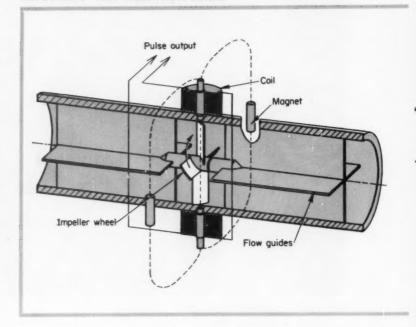
Pressure positions magnet to operate a flow-sensing switch. Any variation of flow rate past the adjustable restriction produces a corresponding pressure change. Thus, the magnet contained in the spring-loaded, pressure-sensing piston moves to operate the reed-type switch. Principle employed in a switch by Gems Co. Inc., Farmington, Conn.

Wear-compensating fulcrum in a selfenergizing disc brake assembly provides uniform brake response during the entire life of a brake friction pad. When wear of the pad moves the ball end of the supporting lever toward the brake disc, the lever rotates on the curved lower face to move the lower pivot also. Principle employed in a brake by BMD Gear Co., Aberfeldy, Scotland.

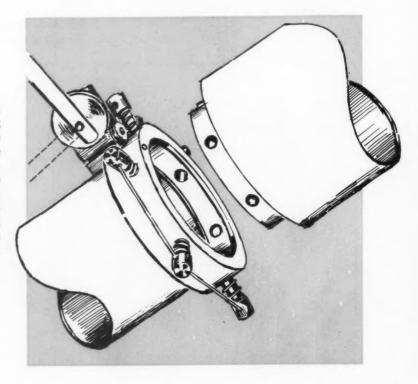


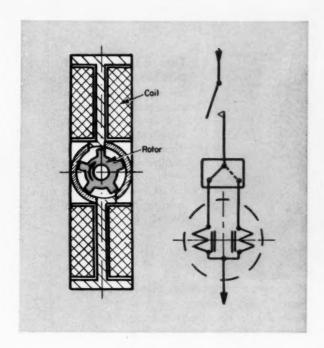
SCANNING THE FIELD FOR IDEAS

Vanes interrupt flux to measure flow rate. External magnets produce a flux path in which a vaned wheel is rotated by the fluid flow. Variations in reluctance produced by changing position of the vanes induce readout pulses in the coils. Thus, pulse frequency is a function of flow rate. Principle employed in a flow meter by Bopp & Reuther GmbH, Mannheim-Waldhof, Germany.



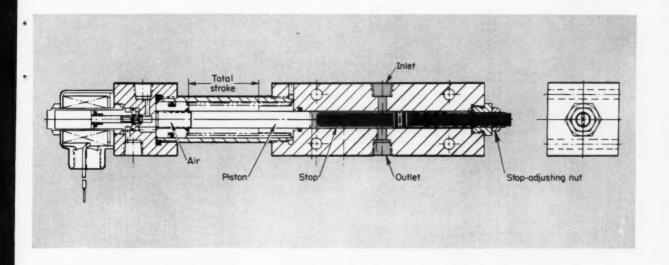
Cable positions pins to provide a quick-acting closure. When tension is applied to the cable, the pins are forced inward simultaneously. When the cable is released, individual springs force the pins outward. Principle employed in a closure by Process Equipment Corp., Lodi, N. J.



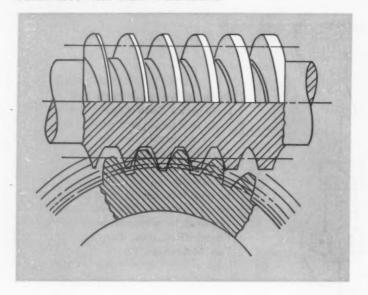


Both drive and stop are provided electromagnetically in a dc stepping motor of an impulse counter. Alternate energization of opposed coils attracts the rotor poles in sequence, permitting counting rates to 100 per second. Principle employed in a counter by Ringsdorff Carbon Corp., East McKeesport, Pa.

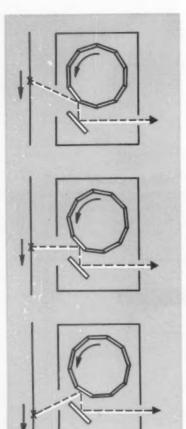
Piston hits stop to control stroke length of an airactuated dispensing pump. Thus, the quantity of material dispensed per stroke can be regulated by a simple mechanical adjustment. Principle employed in a dispensing pump by Airmatic Valve Inc., Cleveland, Ohio.



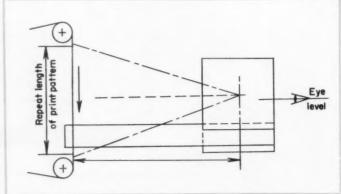
SCANNING THE FIELD FOR IDEAS

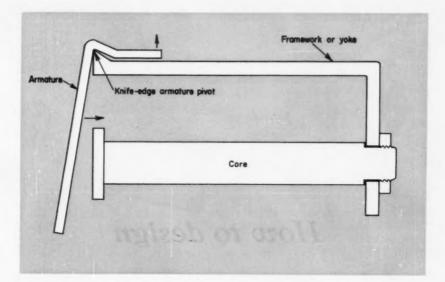


Two different pitches, used to cut the sides of the worm tooth, permit adjustment of a worm gear by axial movement of the worm. Thus, line contact can be maintained between the worm and wheel. Principle employed in a worm gear by Flender-Works, Bocholt, Germany.



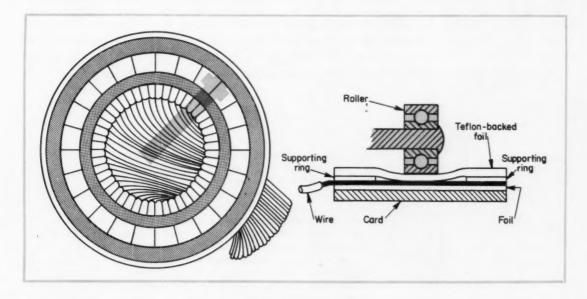
Mirrors "stop" motion of a moving web to permit reading the output of a printing-machine cylinder. Speed of the rotating mirror drum is synchronized with the printing cylinder. Distance between the mirror drum and the print being scanned is proportional to the repeat length of the print pattern. Principle employed in a print scanner by Leedpak Inc., New York, N. Y.

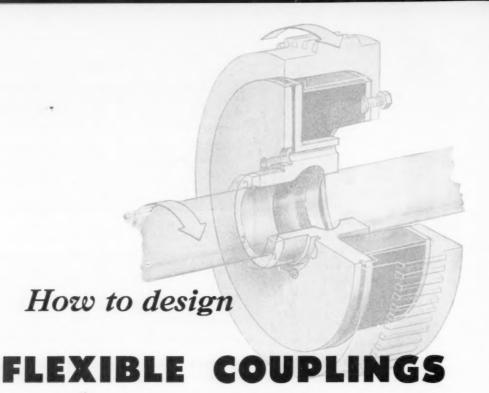




Residual-magnet core holds the armature of a relay in the closed position after the actuating current is removed. The carbon steel core will retain the residual magnetism up to three months. The armature is released by cancelling the field, either by sending a current through the winding in the reverse direction, or by applying the current to a second demagnetizing coil. Principle employed in a relay by Ellis & Frowd, New York, N. Y.

Moving dimple forms contact in a commutator. A gold-foil diaphragm supported over a segmented switch plate is depressed by a revolving roller. The foil dimples in the bearing's path, and sequential contact is made between the foil and the commutator segments. Principle employed in a scanning switch by Technology Instrument Corp. of Acton, Acton, Mass.





to match specific drive requirements

J. R. GENSHEIMER

Supervisor, Product Engineering Lord Mfg. Co. Erie. Pa.

Flexible couplings are generally catalog items. But what if a catalog selection that exactly fills the bill can't be found? Best solution may be a coupling designed specifically for the job. Here are the design details for couplings that use an elastomeric flexible element.

LASTOMERIC flexible couplings are based on a simple design concept: Two hubs separated by an elastomer "cushion" provide a resilient shaft connection that requires no lubrication. In practice, details of design and application vary widely. By altering the shape, size and/or composition of the elastomer section, a broad range of performance characteristics can be provided. Capacities of present designs range from 1/15 to 400 hp, but these values are not limits.

Design of an elastomeric flexible coupling is dictated primarily by the function of the coupling. Key element is the elastomer section which may

be stressed in shear or compression, depending on the specific design and operating requirements.

The Elastomer Section

For this discussion, static compression stress or static shear stress can be considered the stress which is exerted on the elastomer by normal rated torque delivery. Dynamic stress is that which is produced by cyclical forces or excitations originating from the power source or driven unit, or by excursions caused when misalignment is accommodated by the coupling.

Static stress, if held to practical limits, is not the major criterion for determining service life of the elastomer. Fatigue life of elastomers is a function of the severity and frequency of dynamic strain. Important, too, in obtaining maximum service life, is prevention of a return to zero strain once the initial strain due to normal operation is applied. When possible, the coupling design should permit static strain large enough to avoid a return to zero strain during deflection in the elastomer due to dynamic operation.

Selection of a specific elastomer to perform the specific duties must include consideration of many factors. There is no one material which will satisfy all requirements in all applications. Good fatigue life, extreme-temperature resistance, and inherent damping are properties which can be "built-in" to an elastomer when required.

Elastomers can also be compounded to provide effective internal damping for applications requiring the coupling to operate momentarily at critical frequencies or to pass slowly through resonance. Such damping will eliminate the need for auxiliary damping systems which may otherwise be required to reduce high torsional amplitudes during such periods. Most elastomers, however, are amplitude, frequency, and temperature-sensitive. Thus, effective damping

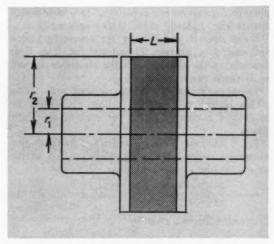


Fig. 1—Simple shear-type coupling design with elastomer section bonded to parallel flange faces.

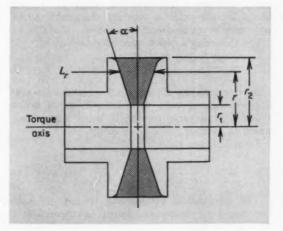
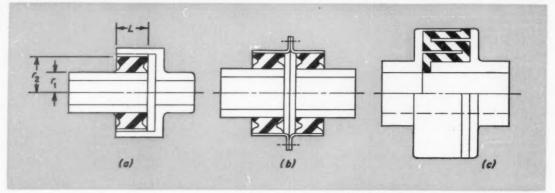


Fig. 2—Shear-type coupling with tapered flange faces to provide constant stress in the elastomer section.



can be determined only by thorough knowledge of the dynamic characteristics of the material at the specific dynamic conditions involved.

Shear-Type Couplings

The shear-type coupling arrangement can be utilized to create many variations in flexible-coupling configurations and capacities. Two basic design criteria are: 1. Static stress. 2. Dynamic strain.

Static stress is induced by the operating torque and should be between 20 and 100 psi. This limit depends on the properties of the elastomer as well as dynamic strain.

Dynamic strain is the single-amplitude strain which occurs at maximum torque. It should be held to a maximum of 75 per cent of the static strain.

Fig. 1 illustrates a basic parallel-face flange design. Maximum stress for a given torque occurs at the outermost fibers of the elastomer. This stress is:

$$g_{\max} = \frac{Tr_2}{1.57 \ (r_2^4 - r_1^4)} \tag{1}$$

Torsional stiffness is given by

$$K_T = \frac{1.57 G (r_2^4 - r_1^4)}{L} \tag{2}$$

Fig. 2 shows a constant-stress coupling. Tapered flange faces provide a constant elastomeric strain and, thus, stress at almost any radius.

For this design, strain can be expressed as

$$\varepsilon = \frac{\phi}{2 \tan \alpha} \tag{3}$$

As this equation shows, strain ε (and stress) at a given angle of twist, ϕ , is independent of radius r and depends only on the included angle (2α) , which is constant for a given design.

From Equation 3,

$$S = \epsilon G = \frac{G\phi}{2\tan\alpha} \tag{4}$$

This equation is cumbersome to use. A more convenient expression for design calculations is

$$S_{max} = \frac{T \cos \alpha}{2.09 \ (r_2{}^3 - r_1{}^3)} \tag{5}$$

Fig. 3—Tube-form shear-type couplings: a, Single tube section; b, series tube arrangement for increased torsional windup; c, multiple-tube design for increased torque capacity.

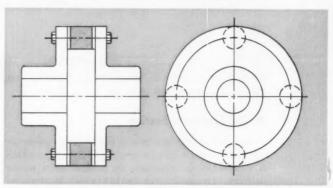


Fig. 4—Shear-type coupling with multiple elastomer shear sandwiches attached to parallel face flanges.

Nomenclature

A = Cross-sectional area of elastomer sandwich, sq in.

 $A_p =$ Compression area of bushing, sq in.

A_s = Shear area at mean diameter of elastomer compression bushing, sq in.

 $d_p = \text{Diameter of bushing pin, in.}$

F = Torque reaction on bushing, lb

G =Shear modulus of elastomer, psi

 $K_A =$ Shear spring rate of each elastomer sandwich, lb/in.

 $K_B =$ Compression or radial spring rate of bushing, lb/in.

 $K_s =$ Shear spring rate of compression bushing, lb/in.

 $K_T =$ Torsional stiffness or torsional spring rate, lb-in./rad

L = Thickness of uniform-section elastomer, in.

 $L_r =$ Thickness of elastomer at radius r, in.

 $L_a = L_{ength}$ of socket for compression bushing, in.

N = Number of elastomer sandwiches or bushings

R = Ratio of compression to shear spring rates r = Any radius from torque axis, in.

 $r_1 = Inside radius, in.$

 $r_2 = \text{Outside radius, in.}$

 $r_b = Bolt-circle radius, in.$

S = Stress, psi

 $S_{max} = Maximum stress, psi$

T =Applied torque, lb-in.

t = Wall thickness of elastomer element, in.

 $\alpha =$ Angle of taper of flange face, rad

 $\varepsilon = Strain, in./in.$

φ = Rotational twist, rad

 θ = Torsional deflection or windup, rad

Corresponding torsional stiffness is

$$K_T = \frac{1.045 G (r_2^3 - r_1^3)}{\sin \alpha} \tag{6}$$

If $r_1 = 0$,

$$K_T = \frac{1.045 G r_2^3}{\sin \alpha} \tag{7}$$

Tube-form type couplings, which consist of concentric metal tubes with elastomer bonded between them, are shown in Fig. 3. General expression for stress is, Fig. 3a:

$$S = \frac{T}{2\pi r^2 L}$$
(8)

Torsional windup θ at torque T is:

$$\theta = \frac{T\left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right)}{4\pi LG} \tag{9}$$

and corresponding torsional stiffness is:

$$K_{T} = \frac{T}{\theta} = \frac{4\pi LG}{\left(\frac{1}{r_{1}^{2}} - \frac{1}{r_{2}^{2}}\right)} \tag{10}$$

Greater torque capacity for a given diameter can be designed into this type by increasing the number of concentric tubes extending from each flange. Such a design is shown in Fig. 3c. Approximate torsional spring rates for this configuration can be determined by calculating torsional spring rates for each tubular section using Equation 10. Total spring rate is additive and will provide the windup for each tubular section. By substitution in Equation 9, torque necessary to provide certain windup θ can be determined. Equation 8 will provide the shear stress for torque delivered through each section.

Fig 3b shows a way for increasing torsional, an-

Design Example

Design a flexible coupling to connect an engine and a transmission. Given data are: Required torsional natural frequency of coupling $f_n = 900$ cycles per min; maximum torque developed, 375 lb-ft; mass moment of inertia of engine and flywheel combination, $I_1 = 30.2$ in.-lb-sec²; mass moment of inertia of transmission, $I_2 = 2.68$ in.-lb-sec².

Torsional spring rate, K_T , required to provide the specified natural frequency f_n , can be determined from

$$f_n = \frac{60}{2\pi} \left(\frac{K_T}{I}\right)^{\frac{1}{2}} = 9.55 \left(\frac{K_T}{I}\right)^{\frac{1}{2}}$$

where I = Total effective mass moment of inertia. For this engine-transmission system,

$$I = \frac{I_1 I_2}{(I_1 + I_2)} = \frac{(30.2)\,(2.68)}{(30.2 + 2.68)} = 2.46 \text{ in.-lb-sec}^2$$

Solving for Kr

$$K_T = \frac{f_{n^2}I}{(9.55)^2} = \frac{(900)^2(2.46)}{(9.55)^2} = 21,800 \text{ lb-in./rad}$$

Torsional windup at rated torque will be

$$\theta = \frac{T}{K_T} = \frac{375(12)}{21,800} = 0.206 \text{ rad (11.8 deg)}$$

It is apparent that this amount of windup is impractical for a compression-type coupling. A shear type must be designed. For a parallel-face arrangement, Fig. 1, using a design stress of 40 psi, the diameter can be determined from Equation 1. For brevity, r_1 can be ignored unless its value nearly approaches r_2 . Thus, from Equation 1,

$$r_2=\left(rac{T}{1.57~S_{
m max}}
ight)^{1/6}=\left[rac{3.75(12)}{40(1.57)}
ight]^{1/6}=4.15$$
 in.

and coupling diameter D = 8.3 in.

From Equation 2, assuming G=100 psi, thickness of the elastomer section is:

$$L = \frac{1.57 \; Gr_2^4}{K_T} = \frac{1.57 \, (100) \; (4.15)^4}{21,800} = 2.14 \; \text{in}.$$

Assume now that an electric motor is used as the power source rather than an engine. Accordingly, torsional impulses are of less magnitude but higher frequency. Assume also that the coupling must accommodate 1 deg of angular shaft misalignment. Maximum permissible coupling diameter because of space limitations is 7 in. Only a small number of couplings is required, suggesting a fabricated design which uses available components.

This requirement narrows the choices to two possibilities: 1. Tube-form type (Fig. 3). 2. Compression type (Fig. 5). Since tube-form couplings are not as suitable for accommodating misalignment, the latter type will be used.

As a starting point, a bolt circle of 5.5 in. diam will be selected, using a bushing of the type shown in Table 1. A type II bushing $(d_1 = 1 \text{ in.}, d_2 = 1.37 \text{ in.})$ with an outer member length, w = 1 in., will be investigated first. Assume operating stress $S_{max} = 200 \text{ psi.}$ Force at bolt circle is

$$F = \frac{T}{\tau_b} = \frac{375(12)}{2.75} = 1635 \text{ lb}$$

Total required compression area $A_c = 1635/200 = 8.17$ sq in. Then, number of bushings needed is $N = 8.17/[1(1)] \approx 8$.

The shear deflection δ due to 1 deg shaft misalignment is

 $8 = 2.75 \tan 1 \deg = 0.048 \text{ in. (single amplitude)}$

For a rubber wall thickness of 0.19 in.,

$$e = \frac{0.048}{0.019} = 0.25 \text{ in./in.} = 25 \text{ per cent}$$

Total strain would be 50 per cent. This result is excessive if high-frequency operation is contemplated. For such conditions larger bushings should be used to reduce total strain.

gular and axial resiliency by using two tube-form sections in series. As compared to the design of Fig. 3a, assuming equal dimensions of each of the elastomer sections, torsional windup at a given torque is doubled for the arrangement in Fig. 3b. In addition, resistance to angular and parallel misalignment is halved. Torque capacity is the same for both designs.

Various degrees of flexibility or torque capacity can be provided by using a number of individual shear sandwiches attached to parallel face flanges, Fig. 4. Equations for determining torsional stress and spring rate in such designs are:

$$S \approx \frac{T}{r_b N A}$$
 (11)

$$K_T = K_A N r_b^2 = \frac{AG}{t} N r_b^2 \qquad (12)$$

Selection of a specific shear-type coupling design is influenced by several factors. Generally, configurations similar to those in Fig. 1 and 2 are the most economical to produce in quantity. For low-quantity usage with applications in the higher rating range, designs such as Fig. 4 are usually the most economical. Many shear-sandwich designs are readily available off-the-shelf, eliminating the need for new tooling to produce the coupling.

Coupling designs shown in Fig. 1, 2, and 4 will readily accommodate shaft misalignment because they are inherently soft (spring rate) in a direction perpendicular to the shaft axis, as well as in "cocking." Also, where longitudinal space is critical, capacities can be increased by increasing the diameter rather than length. Torsional spring rates can be changed easily for a given diameter by varying the elastomer wall thickness or the included angle (2α) , Fig. 2, or by incorporating another elastomer with a different modulus.

Where diameter limitations are imposed for reason of space or speed, designs shown in Fig. 3a and b can be considered. By keeping diameters to a minimum and increasing axial length, large capacities can be obtained. Torsional stiffness is varied by changing elastomer modulus and wall thickness.

These concentric-tube designs offer greater axial flexibility than do the flange type since the elastomer is stressed in shear in the axial direction. Another advantage of the tube type is its ability to operate at higher speeds because of its smaller diameter for a given torque and the confined elastomer arrangement which prevents excessive deflection due to centrifugal force. However, this design does not lend itself to long service life, as compared to the flange type, if it is required to accommodate appreciable shaft misalignment. These designs are excellent for isolating critical torsional-vibration frequencies because of the possibility for varying the torsional spring rate of the elastomer through a wide range without appreciably changing the design.

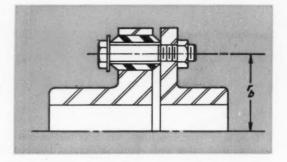


Fig. 5—Compression-type coupling design which uses hollow elastomer bushings inserted in flange sockets.

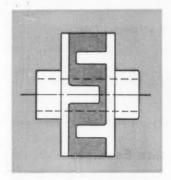


Fig. 6—Compressiontype coupling design for high-torque capacity in limited space.

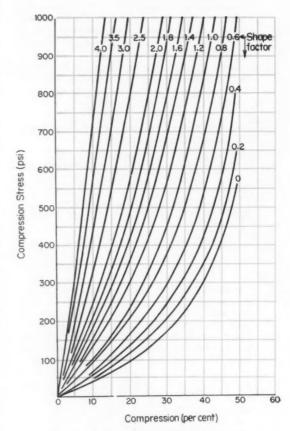


Fig. 7—Stress-strain relationships for typical elastomer pads in compression. Material is 50 Shore Durometer A hardness.

Compression-Type Couplings

In some design situations, it is desirable to stress the elastomer in compression. Basic service-life phenomena, as discussed for shear-type designs, are also applicable to compression loading.

Static stress should be held to the 100 to 500psi range. Single-amplitude dynamic strain should be held to a maximum of 30 per cent of the static strain for long service life.

A common coupling arrangement that uses elastomeric compression-type bushings is shown in Fig. 5. Static stress is determined from

$$S = \frac{F}{A_p} = \frac{\frac{T}{r_b N}}{d_p L_s} \tag{13}$$

Torsional spring rate is given by

$$K_T = K_B N r_b^2 (14)$$

The value of K_B is difficult to calculate since many unknown variables contribute to the spring rate of a bushing loaded in compression. Published information on design procedures for determining compression (radial) spring rate K_B of bushings is limited in scope. Variables, such as length-thickness ratio of the rubber section and strain, greatly affect spring rates. A ready indication of compression rates can be obtained by first calculating the

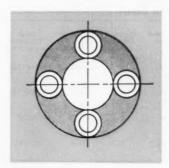
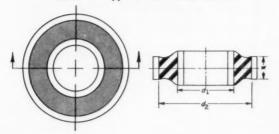


Fig. 8—Elastomer section for compression type coupling which uses reverse arrangement of design in Fig. 5 to provide maximum flexibility under misalignment.

Table 1—Typical Values of Ratio R



Bushing Type	<i>d</i> ₁ (in.)	d ₂ (in.)	w (in.)	R*
I	0.44	0.90	0.38	3.4
I	0.44	0.90	1.0	6
II	1.00	1.37	0.5	4.4
II	1.00	1.37	1.5	10.0
III	2.00	2.75	2.0	9.5
III	2.00	2.75	4.5	20.0

*For values of w between those given for each bushing type, a linear relationship may be assumed for interpolation of E values.

shear spring rate from

$$K_s = \frac{A_s G}{t} \tag{15}$$

Then, with experience, the ratio, R, of compression to shear spring rates can be estimated. To assist in gaining a "feel" for such estimates, typical bushing designs with accurate corresponding R values are given in Table 1.

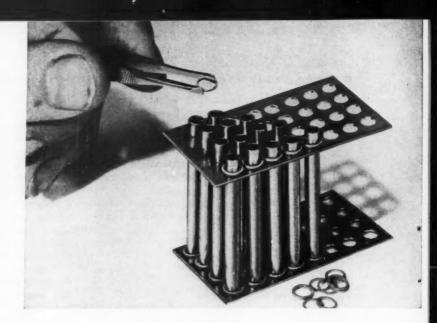
Bushings can be produced in many forms although a bushing in which the elastomer is precompressed in the socket affords the best service life. Here again, precompression should be utilized to the extent that deflections due to static strains should prevent the elastomer from returning to zero strain.

Torsional spring rate can be varied by changing elastomer modulus or wall thickness, or by revising the length and number of bushings on a given bolt circle. When a spring rate lower than can be obtained by these methods is required, the joints can be arranged in series. In a series arrangement, an intermediate plate between flanges is used to house the bushings. The respective shaft flanges are then bolted to alternate bushings. For this arrangement, as compared to previous design, flexibility is doubled for a given number of joints while capacity is reduced by one-half.

Basic design data for the coupling shown in Fig. 6 is more complex than for a shear coupling because of the variables involved. Spring rates of a compression section are a function of the ratio of compression area to free bulge area. This ratio is called the "shape factor." Stress-strain relationships for simple elastomer compression pads with varying shape factors are plotted in Fig. 7. As these plots show, the strain (per cent compression) can be determined by choosing a design stress. Seldom do simple compression pads, from which these plots are derived, lend themselves to coupling design as do various contoured and confined shapes. However, these data allow a close approximation to compression spring rates of nearly flat sections.

Spring rates are not linear as they are for shear loads but, rather, become stiffer as deflection increases. The design shown in Fig. 6, however, is advantageous for applications involving high torque where space is limited. In comparison to other designs discussed here, it has a high spring rate and, thus, will impose high bearing loads if shaft misalignment is to be accommodated. As in all compression-type couplings, the design is "fail-safe." In the event of elastomer failure, the interlocking metal lugs will continue to drive the system.

The arrangement in Fig. 8 is simply a reverse design of the conventional bushing type, Fig. 5. The flange containing the sockets for the bushings becomes the elastomer and the bushings become the metal parts. This arrangement is particularly suited for use in power take-off drives or similar applications where considerable misalignment must be accommodated. The design offers extremely good flexibility characteristics because of the relatively large elastomer-wall thickness and because angularities are accommodated by shearing action in the elastomer.



Selecting

HIGH-TEMPERATURE

Table 1—Typical Brazing Alloys—Properties and Selection Data

Alloy ¹	Composition Balance NI (per cent)	Liquidus Temp (F)	Recommended Brazing Temp ² (F)	Brazing Temp Range (F)	Maximum Service Temp ³ (F)	Recommended Brazing Atmosphere ¹	Recommended Joint Gap (in.)	Strength ⁶	ensile Shear (1000 psi) AISI 304	Joint Ductility* (deg of twist)
AMS 4778	Cr. 13.5; Fe, 4.5; B, 3.5; C, 0.8; Si, 4.5	1900	2150	1950 to 2200	2200	w, x	0.002 to 0.005	56.1	48.0	Over 720
AMS 4778	Cr, 13.5; Fe, 4.5; B, 3.5; C, 0.15 max; Si, 4.5	1970	2150	1975 to 2200	2000	w, x	0.002 to 0.006	57.1	60.7	Over 720
AMS 4777	Cr, 6.5; Fe, 2.5; B, 3.0; C, 0.15 max; St, 4.5	1830	1900	1850 to 2150	1800	w, x	0.001 to 0.004	56.1	37.2	То 720
AMS 4778	B, 3.0; Si, 4.5; C, 0.15 max	1900	1900	1850 to 2150	1800	w, x	0 to 0.002	57.5	33.9	То 720
WG	Cr, 11.5; Fe, 3.5; B, 3.0; C, 0.15 max; Si, 3.5	2000	2100	2100 to 2200	1800	w, x	0.010 to 0.030		• • •	Depends on joint clearance
A	P, 11.0; C, 0.15 max	1610	1800	1700 to 1850	1400	W, X, Y, Z	0 to 0.001		27.6	270
В	Cr. 19.0; Si, 10.0; C, 0.15 max	2075	2175	2100 to 2200	2000	W, X, Y	0.001 to 0.004	98.3	59.3	To 720
0	Cr, 13.0; P, 10.0; C, 0.15 max	1630	1800	1800 to 1950	1575	W, X, Y	0 to 0.001	• • •	31.4	540
D	Mn, 17.0; Si, 8.0; C, 0.15 max	1890	2050	1900 to 2100	1700	W, X, Y	0 to 0.002	69.5	34.4	To 720
E	Cr. 15.0; B. 3.5; C, 0.15 max	1930	2150	1950 to 2200	1800	w, x	0.001 to 0.004	80.0	34.4	Over 720
*	Cr, 10.0; Fe, 2.5; B, 2.0; C, 0.45 max; Si, 2.5	2120	2175	2100 to 2200	1700	w, x	0.005 to 0.020	•••	• • •	Over 720
G	Cr. 11.5; Fe. 3.75; B. 2.5; W. 16.0; Si. 3.25; C. 0.55	2020	2150	2100 to 2200	2200	w, x	0.004 to 0.010	• • •	•••	Over 720

*Designations of alloys other than the AMS compositions are arbitrary. Alloy WG has no AMS designation, but is commonly referred to as "wide-gap" alloy.

*Temperatures shown are average values. Selection of an exact temperature must include consideration of desired joint strength, as alloy G used Hastelloy X base metal; all others. Inconel. Exposure of 500 hr at indicated temperatures produced no deterioration of fillets.

*Brasing atmospheres are: W, pure, dry hydrogen or inert gases; X, vacuum; Y, dissociated ammonia (—60 F dew point or less); Z, exothermic (rich, unpurified 6 to 1 air-to-gas ratio, or purified and dried air).

*AISI 410 and 304 are the base metals used for these tests. Hardness of the AISI 410 was $\rm R_{\odot}$ 38-40; the AISI 304, $\rm R_{B}$ 72. Data represent results of tests using Miller-Peaslee shear-test specimen for brazed joints. *Ductility of joints is shown in terms of angle of twist on type 304 stainless steel, brazed T-specimens 5 in. long, with 0.032 by 0.375 in. legs. Values shown indicate angular twist necessary for joint fracture. For practical reasons, 720 deg was the maximum twist imposed. Where 'over 729' is shown, the test specimen did not fracture and showed evidence that the joint would withstand additional twisting; ''to 720'' indicates no break at 720 deg, but evidence of impending failure was present.

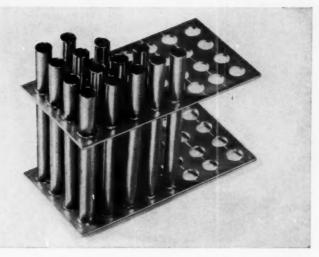


Fig. 1—Prefabricated brazing rings (alloy AMS 4776) minimize assembly time and provide uniform, high-quality joints in heat-exchanger assemblies (Type 347 stainless steel). This combination of base metal and brazing alloy minimizes carbon precipitation—which would reduce corrosion resistance—during slow cooling cycle in dry hydrogen retort.

BRAZING ALLOYS

Nickel-base materials for service temperatures to 2200 F

R. L. PEASLEE

Vice President Stainless Processing Div. Wall Colmonoy Corp. Detroit, Mich. STAINLESS-STEEL components for high-temperature operation are often economically joined by brazing. The first commercial nickel-base alloy for these applications, AMS 4775, is still the most widely used material for well-diffused, high-strength, heat-resistant joints. Additional alloys have since been developed to meet other specific requirements. This article discusses properties and applications of the "standard" alloy and of the other common nickel-base brazing compositions.

Alloys

Composition and general properties of typical nickel-base brazing alloys are shown in Table 1. All alloys listed are available in powder form. Some of these are also available as cast rod, plastic bonded sheet, plastic bonded wire, flux-powder paste and/or special prefabricated forms, Fig. 1.

These alloys provide a range of properties and joint characteristics for applications involving thin-material sections, for atomic reactor core assemblies, for large, machinable fillets, and for tight or deep joints.

Application

Generally, the nickel-base filler metals are suited for brazing parts for jet and rocket engines, automo-

Fig. 2—Nozzles of combustion chamber for jet-engine starter are furnace brazed to base casting at 2150 F with alloy AMS 4775. Casting and nozzles are made of Series 300 stainless steels.



Table 2—Selector Chart for Brazing Alloys

	Boron-Containing Alloys							Silicon- Containing Alloys		Phosphorus- Containing Alloys		
	AMS 4775	AMS 4776	AMS 4777	AMS 4778	WG	E	F	G	В	D	A	C
Property												
Joint Strength*	1	1	1	2	3	1	3	1	1	3	4	2
Diffusion with Base Metal	1	1	2	2	1	2	3	3	4	4	4	5
Fluidity	3	4	0	2	5	2	4	4	2	1	(1)	1
Application				_		_		_	-			
High-temperature, high-stress, moving components	(1)	1	2	2	3	1	3	1	1	3	3	3
Heavy, stationary structures (variable gaps)	1	1	1	2	1	1	1	1	2	3	3	3
Honeycomb and other thin materials	3	3	2	2	3	2	3	3	1	1	1	1
Atomic reactor core assemblies†	X	X	X	X	X	X	X	X	1	1	2	1
Large, machinable, or soft fillets	2	2	3	3	1	3	1	2	3	3	3	3
Contact with liquid metals (NaK, Hg)	1	1	1	1	2	1	1	1	1	2	3	1
Tight or deep joints	3	3	(2)	(2)	3	(2)	3	3	2	1	1	1
Torch brazing (with special flux)	1	1	0	1	1	2	1	1	2	2	2	2

Rating of 1 is best choice, 2, next best, etc. Arbitrary alloy designations are the same as those in Table 1.

*Joint strength also depends on brazing cycle, joint design, and joint clearance.

†Boron-containing alloys are not suitable for atomic reactor core assemblies. These metals (rated X for this application) have high neutron-absorption ratios.

tive components and accessories, nuclear-reactor components, airframe structures, honeycomb sections, heat exchangers, and dairy, chemical, medical, and food-processing equipment.

Specific application recommendations and com-

parative physical properties of the nickel-base brazing alloys are presented in Table 2. Choice of the filler metal best suited for a particular brazed component depends upon: 1. Base metals. 2. Joint design. 3. Brazing operation (method, time, temperature).



Fig. 3—Because of low diffusion characteristics, alloy AMS 4777 is used to braze thin (0.010 in.) bellows section in exhaust-tube assembly for diesel engine. This filler metal has the best corrosion and oxidation-resistance properties of the lower-melting materials.

 Strength and service requirements the completed joint must meet.

Generally, a high brazing temperature improves joint strength and ductility, increases remelt temperature, and reduces joint hardness.

If an application requires strong joints for high-temperature, high-stress service conditions (turbine blades and rotors, for example) the filler metal should have high diffusion and solution properties with the base metal. Recommended brazing materials for this kind of service are AMS 4775 (Fig. 2), AMS 4776, alloy E, and alloy G. Brazing is normally performed at the upper end of the brazing temperature range.

If an assembly is constructed of extremely thin metals such as in honeycomb structures and some heat exchangers, a filler metal possessing a low solubility factor with the base metal is preferred. Recommended brazing materials for this kind of service are: AMS 4777 (Fig. 3), AMS 4778 or alloy B for temperatures to 1800 F; alloy C or D for service temperatures to 1600 F. Brazing on components having thin sections is normally performed at the lower end of the brazing-temperature range.

For applications involving deep brazed joints with close tolerances—fuel nozzles and thermocouple harnesses, for example—a filler metal with a high flow rate such as alloy B, C, D, or AMS 4778 is recommended.

Boron-containing nickel-chromium base brazing alloys are not recommended for atomic reactor core assemblies. These filler metals possess high neutronabsorption ratios which cannot be tolerated in these applications.

Tips and Techniques

Drawing Large Arcs

Points necessary to plot a large arc can be found quickly, and with little chance of error, by the following method.

From A, draw chord arcs at points corresponding to assumed chord lengths c_1 , c_2 , c_3 , etc. Calculate distances y_1 , y_2 , y_3 , etc. from

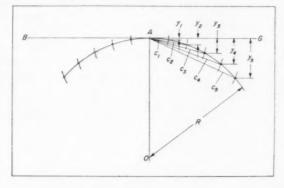
$$y = \frac{c^2}{2R}$$

Lines drawn parallel to a tangent to the arc—at point A—at distances y_1 , y_2 , etc., will intersect the chord arcs at points on the required arc.

Example: Draw an arc with R = 30 in.

Draw line BG as a tangent to the required arc. Assume chord lengths $c_1 = 1$; $c_2 = 2$; $c_3 = 3$; etc. These are arbitrary and are chosen simply because they are easy to use. From A, draw chord arcs at

chord dimensions c_1 , c_2 , c_3 , etc. Then, from the equation, $y_1 = 1/60 = 0.017$; $y_2 = 1/15 = 0.07$; $y_3 = 3/20 = 0.15$, etc. At each of these y values, draw a parallel to BG. The intersections with the chord arcs are points on the required arc.—Frank Murray, Chicago, Ill.



DC Motor Control

Part 5—Basic Controllers and Their Application

... descriptions, service classes, operational concepts

J. RONALD WICKEY

Staff Engineer The Clark Controller Co. Cleveland, Ohio

GENERAL-PURPOSE controllers are designed for usual service conditions, as defined by NEMA, and cover a wide range of basic applications. Controllers are usually simple and can be nothing more than a motor-starting device.

Definite-purpose controllers are designed for unusual service conditions or for use on definite types of applications. These controllers can become quite complex and involved.

Both types of controller are discussed here. Paragraph and section references are taken from NEMA Standards Publication IC 1-1959.

General-Purpose Controllers

An elementary type of dc magnetic starter is shown in Fig. 1. In conformance with NEMA IC 1-31.61.A, it is an enclosed nonjogging, nonreversing starter for motors having a 2 to 1, or less, speed range by field control and a maximum rating of 5 hp at 115 v and 10 hp at 230 v. It also includes: 1. A single-pole line contactor. 2. Necessary accelerating means. 3. A single-element overload relay. 4. A starting resistor. 5. Provision for a separately mounted pushbutton.

It is evident from these features that this starter is limited in its application and flexibility. Nevertheless, it fulfills a need for a simple and inexpensive starter on applications where a small motor is used, where service-duty requirements are light, and where additional modifying features and devices are not necessary.

The starter in Fig. 1 combines the features of a line contactor and accelerating means into a single dual-purpose unit which has only one magnetic structure and operating coil. Essentially, it is a two-pole contactor—one pole operates instantaneously while the other pole closes after a time delay determined by an air-dashpot timing mechanism. This simple mechanism provides a compact and practical dual-purpose device. The starter is suitable for a maximum of 10 hp at 230 v when the proper power-circuit resistor and heater for the thermal overload relay are used.

Shown in Fig. 2 is a dc starter for general-purpose machine-tool application, NEMA IC 1-31.61.B and C. This type of starter is designed for motors of all conventional power ratings, including the larger ones which are within the full range of standard NEMA contactor ratings.

Basically, this class of starter is available in three types: Plain nonreversing, nonreversing with dynamic braking, and reversing with dynamic braking. There are also several forms of this starter. For example, such starters can have, either separately or in combination, 2, 3, 4, or 5 accelerating points, a field accelerating relay, and/or a field-loss relay.

In addition to these basic types and forms, a

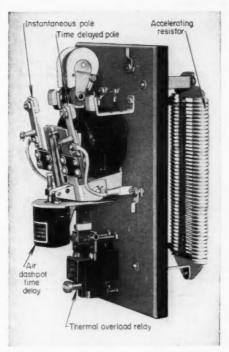


Fig. 1—Dc starter conforming to minimum NEMA requirements for general-purpose applications. Enclosure is not shown.

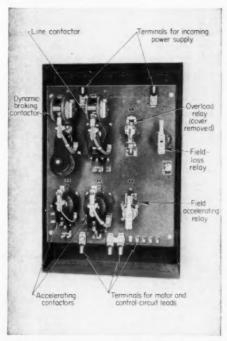
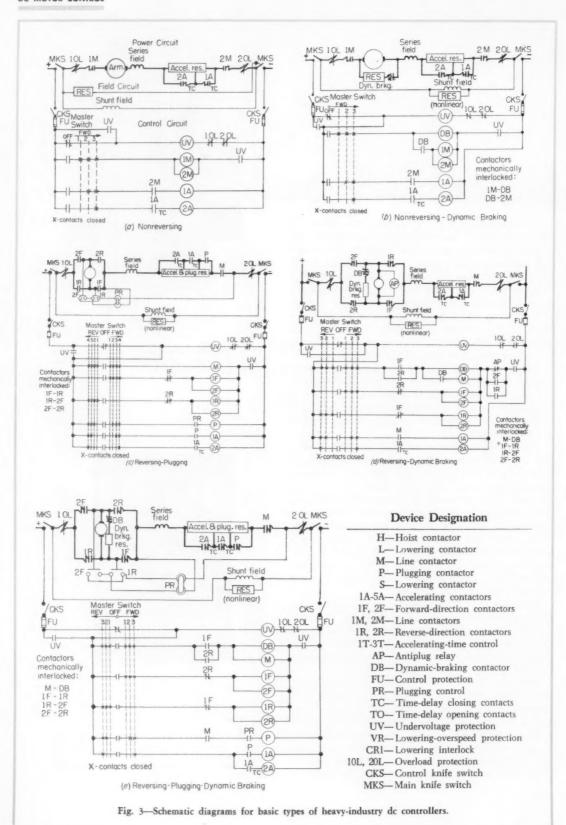


Fig. 2—Typical dc starter suitable for generalpurpose applications. Starter shown is designed for use with an adjustable-speed motor. Accelerating resistor is mounted behind the slate panel. Enclosure cover is removed.



166

starter can be modified in several other ways. Among the devices that can be added are a field-decelerating relay; jogging, interlocking, or sequenc-

ing relays; and control-circuit fuses.

These types of starters are intended for wall-mounting in a NEMA Type 1 enclosure. However, some sizes and types, especially if modifications or additional equipment are included, are too large for the wall-mounted construction and are therefore built as floor-mounted starters. Similarly, power-circuit resistors are basically self-contained in the starter, but for many of the larger starter sizes the resistors must be supplied as a separate assembly.

Definite-Purpose Controllers

Dc magnetic controllers for steel-mill machinery include a number of specific applications. The category, crane controllers, is narrower but represents a field large enough for separate consideration. Both categories are discussed here.

Heavy-Industry Controllers: This class of controllers is designed for heavy-duty use with steel-mill auxiliaries in conformance to NEMA IC 1-41. Such machines are used directly in the processing of steel, such as screwdowns and manipulators, but do not include cranes and main rolling drives, NEMA IC 1-1.109. While this definition inherently covers a broad area of application, it is further extended, by convention, to heavy industries and heavy-duty applications other than the steel industry. Hence, this class of controller is considered the standard requirement for almost any heavy-duty machine.

For this group of controllers, NEMA standards specify a certain minimum of equipment and features which are appreciably in excess of those specified for general-purpose starters. The most important of these requirements are:

- 1. Two-pole main-line knife switch with lockout device.
- 2. Two-pole fused control-circuit switch.
- 3. Two automatic-reset overload protective relays.
- 4. An undervoltage relay.
- 5. Minimum contactor size of 100 amp 8-hr rating.
- Accelerating contactors of the same rating as the main power-interrupting contactors (not a reduced size as is permissible on general-purpose starters).
- Two line contactors on nonreversing controllers.
 A set of reversing contactors plus one line contactor
- A set of reversing contactors plus one line contactor on reversing controllers.
- A separate dynamic-braking contactor on any controller which includes the dynamic-braking function.

This group of controllers is always floor mounted and may be either the open or the enclosed type.⁴ The Class D frame construction is the basic standard, but more elaborate types of frame construction are often used.

The five types of basic controllers in this group are:

- 1. Nonreversing, Fig. 3a.
- 2. Nonreversing with dynamic braking, Fig. 3b.

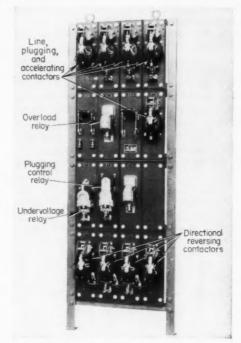


Fig. 4—Typical dc controller for either bridge or trolley motion, heavy-duty crane service. Construction is open type, individual slate. Contactors are NEMA Size 3, which carries a rating of 100 amp for each 8-hr cycle.

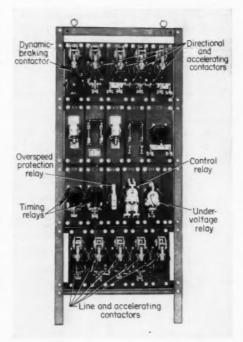


Fig. 5—Typical dc controller for hoist motion, heavy-duty crane service. Construction is open type, individual slate. Contactors are NEMA Size 3.

⁴References are tabulated at end of article.

- 3. Reversing with plugging, Fig. 3c.
- 4. Reversing with dynamic braking, Fig. 3d.
- Reversing with plugging and dynamic braking—a combination of types 3 and 4—Fig. 3e.

Modifications of these five general types are numerous and can include one or more of the various field-circuit control devices, additional accelerating contactors, a magnetic brake and its operating relay, limit switches, and metering and instrumentation devices. The reversing-dynamic braking controller has a wide range of possible applications and is probably the most widely used of the five general types.

Crane Controllers: Because of the requirements for and wide application of crane controllers, they are recognized as a separate definite-purpose class.

A conventional crane is usually driven by a minimum of three motors—one each for bridge, trolley, and hoist—mounted on the moving structure. As a result, a number of power and control circuits must be carried between operating devices, con-

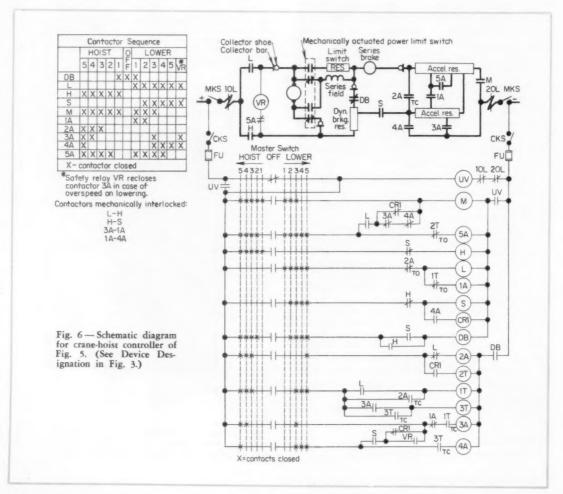
trollers, and motors by means of trolley rails or wires and collector shoes. To minimize the number of trolley conductors, the simplest, functionally satisfactory types of motor and controller are used.

Because the series motor provides high starting torque and rugged mechanical construction, it is almost universally used on cranes operated from a constant dc voltage. In special cases where the high speed at light load is objectionable, it can be overcome by adding a light-shunt field to the motor or by providing the control system with a light-armature shunt or "speed-limiting" resistor.

To prevent selection of a crane controller more expensive or bulky than necessary, several service classes have been established in NEMA IC 1-42:

Class I—stand-by service. A crane used to install machinery and thereafter kept only for maintenance purposes. Typical examples are cranes in pumping stations, substations, and power plants.

Class II—light industrial service. A crane which is used infrequently. Typical examples are cranes in warehouses and assembly areas. Monorail-type cranes and



floor-operated cranes are normally in this classifica-

Class III-regular industrial service. A crane which is used frequently. Typical examples are cranes in machine shops and manufacturing plants.

Class IV-continuous handling service. A crane which operates continuously. Typical examples are cranes carrying a magnet or bucket for continous handling of such materials as pig or scrap iron, stone, or coal.

Class V-steel mill and heavy industry service. A crane which is used in steel mills or where similar conditions are encountered. Typical examples are cranes handling hot metal either in a ladle or a mold, or possibly by tongs.

Because of their physical construction, two basic types of cranes, cab-operated and floor-operated, are recognized.

Cab-Operated Cranes: On the basis of control requirements, and for practical purposes, one portion of NEMA IC 1-43 applies to cab-operated cranes for Service Classes I, III, IV, and V. Another portion, which covers cranes for Service Class II, is less stringent and is limited to motors of 55 hp

The typical heavy-duty controller for cab-operated cranes is the one most worthy of detailed considera-

Bridge and Trolley Motion: Controllers for crane bridge and trolley provide reversing-plugging operation, Fig. 4. Because bridge motion usually requires a motor with a greater power rating than trolley motion, the bridge controller is likely to have a higher rating and larger contactor size than the trolley controller for the same crane.

NEMA IC 1-43.B.62.A for bridge and trolley controllers is similar to the standard for the reversing-plugging controller used with steel-mill auxiliaries. The main difference is that the bridge or trolley controller is required to have one more accelerating contactor to provide smoother starting and more steps of speed control.

Because they perform only one basic function and control only one type of motor, crane bridge and trolley controllers are highly standardized. Although NEMA requires a minimum of three hand-controlled speed points in each direction, five-point master switches for bridge controllers are conventionally provided. Four-point master switches can also be specified.

Hoist Motion: A controller for hoist motion, Fig. 5, is inherently more complicated than a bridge or trolley controller because of special requirements in lowering. The load is usually great enough to cause it to move downward because of its own weight, thus "overhauling" the motor.

With a light or overhauling load, series-motor speed increases rapidly. To obtain the desirable characteristics of a shunt-wound motor under such conditions, the series field is reconnected as a shunt field by means of switching and resistor arrangements. All dc crane-hoist controllers use this general method of operation in the lowering direction.

The diagram of a hoist controller is shown in Fig. 6. During hoisting, the armature, series field, and accelerating resistor are connected in series across the power supply. As the master switch is advanced, the accelerating contactors short out various portions of the accelerating resistor as is conventional.

During lowering, the armature and series field are connected in parallel across the power supply. Each path includes a section of accelerating resistor. Thus, the drive operates as a shunt-wound motor. Resistance is progressively cut out of the armature circuit and inserted in series with the field. In the last switch position the armature is essentially connected directly across the power supply, and current through the series field is reduced to about 50 per cent of its full-load value.

These connections also provide a dynamic-lowering loop. If the load is overhauling, the motor acts as a generator and forces current through the loop formed by the armature, the series field, and the resistors. As the resistance in the dynamic loop becomes greater, the speed of the motor will increase to provide sufficient retarding torque to balance the requirements of the load.

As the master switch is advanced, the values of the resistors in the circuit are changed. Hence, there is established a different basic operating speed for each position of the master switch.

NEMA IC 1-43.B.62.C applies to hoist controllers.

Floor-Operated Cranes: Compared to cab-operated cranes, floor-operated cranes can use smallersize contactors, fewer accelerating contactors, fewer hand-controlled speed points, and less elaborate protective disconnect means. Because fewer components are required, protective devices and the hoist controller are usually combined into one assembly and bridge and trolley controllers into another. NEMA standards limit motor size for these types of cranes to 35 hp or less.

Operationally, floor-operated cranes are similar to cab-operated cranes. Bridge and trolley controllers are the reversing-plugging type. Hoist controllers usually use dynamic lowering and can accommodate mechanical or electrical load brakes.

Floor-operated cranes are covered by NEMA IC 1-44. Recognition is limited to Service Classes I and III, which are considered together, and to Service

Final article in this series will discuss the basic concepts of adjustable-voltage dc control.

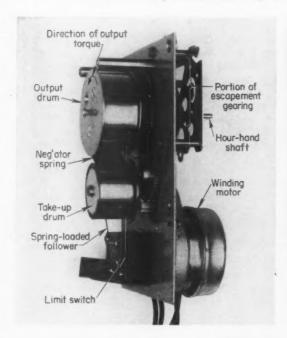
REFERENCES

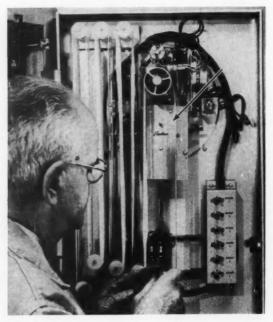
This article is the fifth in a series by J. Ronald Wickey on dc motor control. Previous articles and the issues of MACHINE DESIGN in which they appeared are:

- 1. Motor Types and CharacteristicsJuly 20, 1961
- 2. Circuit Functions of Control DevicesAugust 3, 1961
- 3. Basic Controller Hardware ...
- 4. Accessory Devices and Controller Construction . . August 31, 1961

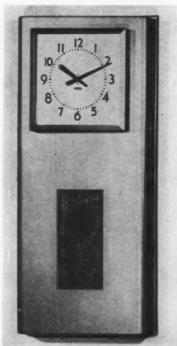
Constant-Torque Neg'ator Spring Powers Standby Clock Motor

STANDBY mechanical clockworks to keep institutional programs, like school sessions, going in spite of power failure have been provided with more efficient motors. Program tapes to ring bells, switch lights, trip locks, etc. proved too much of a burden for an ordinary clock spring to carry accurately for more than 6 hours. Neg'ator springs with constant torque and long deflection are applied directly to the hour hand and provide enough power to operate tape drums as well as the clock. Output is controlled through a conventional escapement.





ELECTRIC MOTOR WINDS the Neg'ator clock spring. A limit switch shuts it off when the spring is fully wound. A brake in the escapement, electrically actuated, keeps the mechanical clockworks from operating while electricity is on. Power failure releases the brake and lets the mechanical clockwork take over.



TAPES controlling bell sequence and timing demanded more torque output than an ordinary clock motor could produce over long periods. Neg'ator motor in the box (arrow) furnishes enough power to drive the system for 15 hours.

MASTER CLOCK, built by Standard Electric Time Co., uses a Neg'ator spring developed by Hunter Spring Co., div. of American Machine & Metals Inc., Lansdale, Pa.

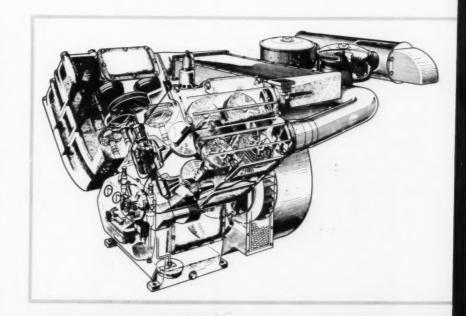
Short-Stroke Pistons Increase Air-Compressor Output

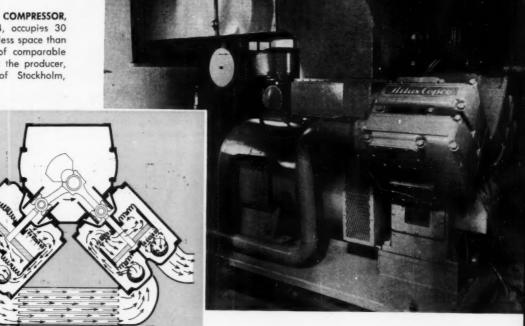
RADICALLY oversquare pistons in a new compressor produce high output with relatively little loss from vibration. Larger valve area means lower air intake pressure drop, and higher permissible shaft speed means a smaller motor. Result is an unusually small two-stage air compressor delivering 565 cfm at 100 psi.

ALL STROKES work in the double - acting cylinder arrangement. Each piston discharges from one face as it recovers with the opposing face. Intercooler uses discharge cooling air from the engine.

stroke LENGTH is 21 per cent of the diameter of the low compression cylinder. Resulting low piston speed (max = 10.6 ft per sec) causes less reversing shock, and therefore less vibration than normal. The compressor needs only comparatively light base mounting.

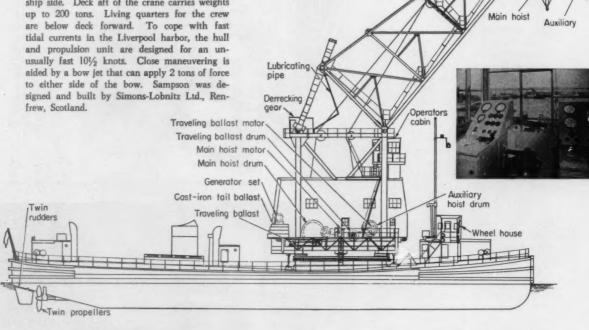
COMPACT COMPRESSOR, called the DT4, occupies 30 to 50 per cent less space than other models of comparable capacity claims the producer, Atlas Copco of Stockholm, Sweden.

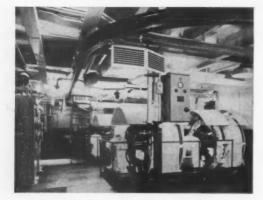




Pump Steers Crane Barge

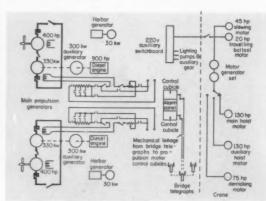
DIESEL-ELECTRIC floating crane shortens turnaround time in Liverpool harbor. It's the latest of a fleet of three that handles cargo, dockside work, salvage, and harbor maintenance. The hull is divided into 9 watertight compartments. Engine room is in an inner shell 4 ft from the ship side. Deck aft of the crane carries weights and propulsion unit are designed for an un-



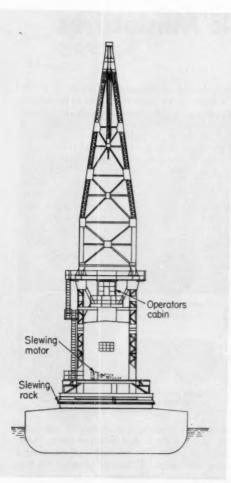


EACH DIESEL drives one propulsion and one auxiliary generator. When the 900-hp operating diesels are shut down, essential services are maintained by two standby 30-kw diesel-generator sets.

CRANE OPERATOR'S CAB is placed high on the superstructure where his view of the crane's work is unimpaired by surrounding obstacles. Mechanical structure of the crane was manufactured by Cowans Sheldon & Co. Ltd.

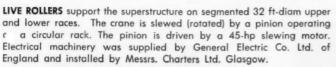


In Close Quarters



TRAVELING BALLAST rolls on guide rails the length of the machinery house. It is positioned to keep the crane's center of gravity within its bearing circle and avoid tension loads on the kingpin. When the crane hooks are empty, the 81-ton traveling ballast moves forward to counteract the tail ballast. When the crane is loaded to capacity, the traveling ballast moves to the rear position, adding its weight to that of the tail ballast to balance the movement of the load.

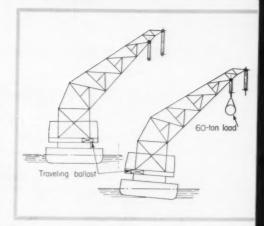
MANEUVERABILITY is a problem with the slow speeds and large wind area typical of a floating crane. On demand from the bridge, a centrifugal pump draws water from beneath the hull and ejects it in a jet to one or the other side as chosen by the helmsman. This gives a side thrust of 2 tons about 20 ft back of the bows for tight maneuvering.

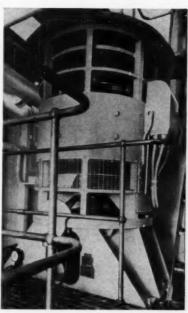












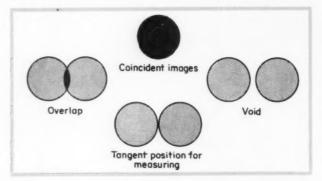
DERRICKING THE JIB is done with two double-start, buttress-thread I e a d screws driven by a 75-hp motor. Telescoping guards protect the threads above and below the working position.

Eyepiece Rotating prisms

RHOMBOIDAL and right triangular prisms are cemented together to make each of two prism blocks. Interface between the cemented prisms is lightly silvered to make a semi-reflecting surface. When the instrument is set at zero shear (imaged displacement), the two images combine to form one image in the eyepiece. Images are separated by rotating the prisms in opposite directions about the objective axis. If each of the prisms rotates through an angle θ , then shear between images is $2 \sin \theta$.

Image Splitter Measures Fragile Miniatures

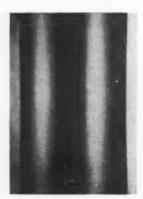
Measurement Accuracy, limited by the resolving power of a conventional microscope, is improved ten times with a new image-splitting eyepiece. It was developed to measure necking in 0.001-in. tungsten wire. Micrometer calipers bridged necks in the wire or gave false readings by making artificial "necks." In addition the order of accuracy for such instruments was far out of range of the desired results (1 per cent error in 0.001 in. diam). Previous microscope techniques called for a great deal of operator skill and concentration. Results were spoiled by a slight jar to the instrument. In the new instrument, images move with the optical elements when the microscope is jarred, and the setting is rarely destroyed. Settings with errors of not more than 1.5 microinches have been obtained under some conditions.



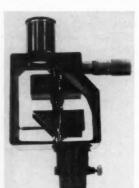
OBJECTS are measured by separating the images to the point where there is neither overlap nor a void between them. After the shear is read, direction of shear is reversed until the images are just tangent on the other edge. Difference between the two readings will be twice the object's diameter.

GLASS FIBER tapers
0.00008 in. in the
length shown. Shear
setting for edge-to-edge
contact near the center
of the photo clearly
shows the degree of accuracy possible with
this technique. Diameter
of the fiber is 0.008 in.

Objective







SHEAR ADJUSTMENT is operated by a micrometer spindle bearing against a lever. At zero shear the axis of the lever is perpendicular to the axis of the spindle. Under these conditions there is linear relationship between shear and micrometer reading. Image splitter is made by Cooke, Troughton and Simms Ltd., Haxby Rd., York, England.

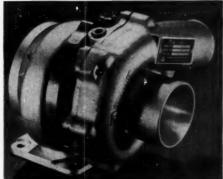
Center-Mounted Turbocharger Spool

Spins Up 110,000-rpm Tornado

Spent exhaust

Bearing

Air from air cleaner
Compressed air to engine



OIL FILM DAMPING keeps a pint-size diesel turbocharger from excessive vibration at speeds up to 110,000 rpm. Pressure ratios of 3 to 1 can be attained by the three-inch unit. Engine oil, used both as coolant and lubricant, flows through the bearing housing after lubricating the center-mounted bearing. Oil films damp out vibration from any slight eccentricity after balancing. Contrary to usual practice, the bushing-type bearing is pinned to keep oil passages in line. The 12-lb turbocharger, designated model 317, was developed by the Turbocharger Works of the Thompson Products Valve Division, TRW Inc., Cleveland, Ohio.

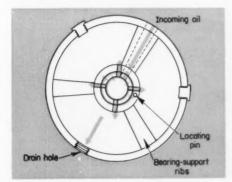


Bearing

Impeller

SINGLE-BEARING DESIGN simplifies external housing problems. The turbocharger is mounted on a base that is also turbine inlet. Compressor housing and bearing housing can be removed without dismounting the turbine housing.

Heat shield



turbine heat shield maintains pressure for positive positioning of the shield, but yields to thermal expansion.

> Compressor housing

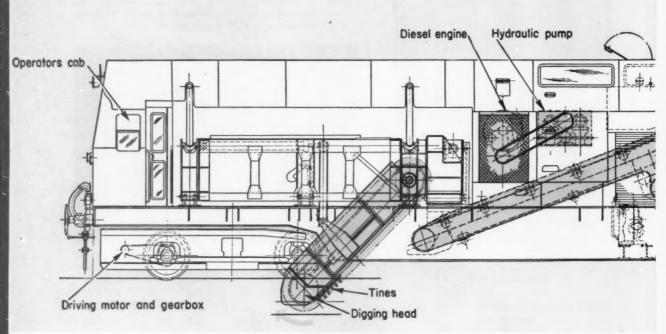
OIL ENTERS the bearing housing through one of the bearing-support ribs. It forms films between bearing and support, and bearing and shaft. Afterward it passes into the large chambers of the bearing housing and then through the unplugged drain hole.

Bearing housing

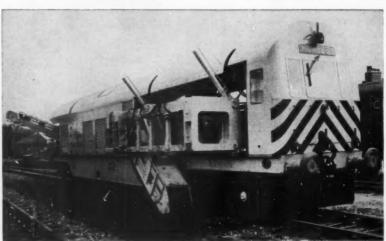
Locating pin

Self-Propelled Ballast Cleaner

EFFICIENT DRAINAGE of railroad track beds depends on ballast that is not clogged with debris. A new British unit digs up shoulder ballast, screens it, and replaces the cleaned ballast at 600 yd per hour. In an hour's time it conditions 300 tons of stone ballast. It can also condition ballast in the area between track beds by moving the working head outboard on booms. Ballast under the ties is cleaned sufficiently by rain water flushing into the clean ballast at the tie ends. The diesel-hydraulic cleaning machine, developed by the Hunslet Engine Co. Ltd., Leeds, England, uses a 208-hp Rolls Royce type C6TFL diesel engine driving four hydraulic pumps. Traction bogie is driven by a 80-hp hydraulic motor. Conveyor, screening, and positioning machinery is also hydraulically driven.

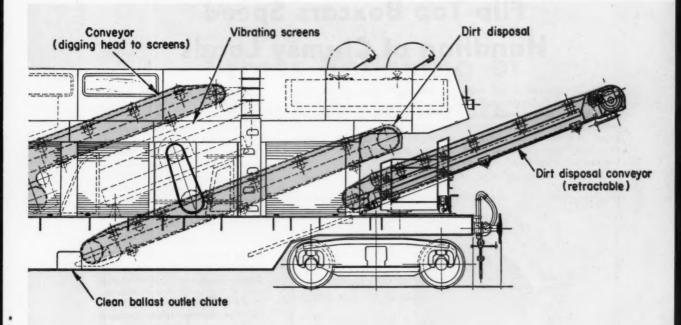


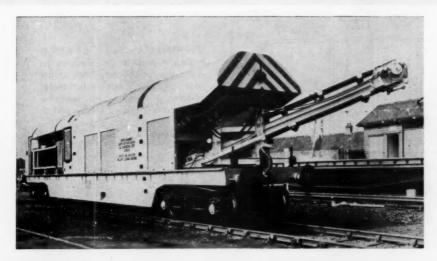
DIGGING HEADS move in and out on booms to establish width of cut. The booms are raised or lowered hydraulically to establish depth of cut. Digging units can be hoisted inboard for travel to and from the yard.



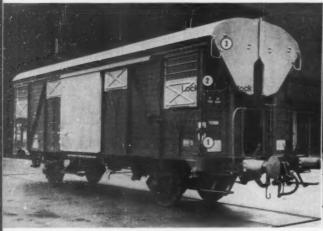
Conditions Railroad Beds on the Run

REMOVABLE hardened steel picks or tines are fitted to the digging belts. Hydraulically driven digging heads are independently controlled for speed and depth of cut. Ballast conveying systems are completely divided so ballast returns to the side of the track from which it was dug. Conveyors are 24-in. troughed belting. Mesh of the double-deck vibrating screens is suitable for stones from 2 in. to 3/4 in. A center plate maintains independent screening of right and left ballast.





DIRT-DISPOSAL CON-VEYOR swings to either side to drop dirt off the right of way, or it can point to the rear and load dirt on a following car.





Flip-Top Boxcars Speed Handling of Clumsy Loads

LOADING of long stock or bulk goods is no problem for Swiss railroads using a new top-opening freight car. Billets, lumber, or machinery nearly as long as the car are quickly loaded through the open top by crane. Unpackaged goods like grain can be bulk-loaded by positioning the car under a suitable hopper or elevator. The two halves of the roof lock together in a water-proof joint when the car is closed. The car was designed by Schindler Carriage and Wagon Co. Ltd., Prattelin, Switzerland.

Roof safety latch

Counter balancing spring

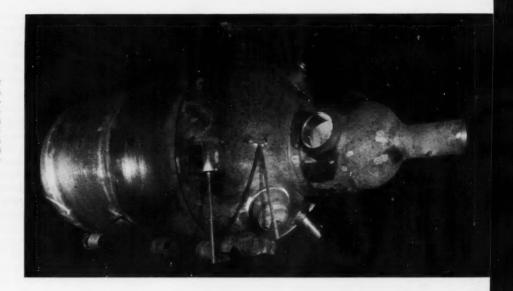
SEQUENCE for opening the boxcar roof is:

- 1. Release the safety latch.
- 2. Unlock the roof segments.
- 3. Pull the roof segments down. To close the car, the operation is reversed. Designer points out the entire operation can be performed without getting on the roof—an advantage in electric railway systems.

ENTIRE ROOF area is open for loading with the roof segments pulled down. Since roof halves extend beyond the usual clearance envelope in the open position, the manufacturer recommends cars be closed for humping, shunting, or other yard movement.

counterbalancing SPR!NG makes it possible for one man to move the roof. Safety latch at the roof line guards against accidental opening in transit. It's operated by a crank-like lever at one end of the car.

Fig. 1—Nuclear reactor pressure vessel is stress relieved to meet code requirements. Wall thickness is 3 in. Materials are commercial ASTM-A212 grade B carbon steel internally clad with 1/4-in. thick 304L stainless steel.



Stress Relieving of Steel Weldments

- Should plate thickness alone govern when stress relieving is necessary?
- What service conditions are conducive to brittle fracture and how can brittle fracture be avoided?
- This article, a practical guide on stress relieving, answers questions like these and brings into focus some controversial regulations from the welding codes.

LOUIS J. LARSON

Consulting Engineer Staff Engineering Allis-Chalmers Mfg. Co. Milwaukee, Wis.

ELDED ships have broken in two, bridges have collapsed, big pipelines have ruptured, and huge weldments in miscellaneous machines and equipment have failed under astonishingly small loads. Such failures are often attributed to "brittle fracture." Stress relieving after welding is one way to prevent brittle fracture. But huge weldments are generally not easy to stress relieve. Nor is stress relieving always necessary.

Thermal stress relieving consists of heating a weldment to approximately 1150 F, holding it at that temperature for a suitable length of time, and cooling it in a controlled manner. Stress relieving is not annealing by heating to a temperature above the critical and cooling in the furnace. Neither is it normalizing by heating above the critical and air cooling. Since the terms "stress relieving" and "annealing" are sometimes used rather loosely and in-

terchangeably, these distinctions are mentioned here.

As the term "stress relieving" suggests, the primary purpose of the treatment is to eliminate or at least greatly reduce stresses in structures which have been welded. The most common and important reasons for stress relieving are:

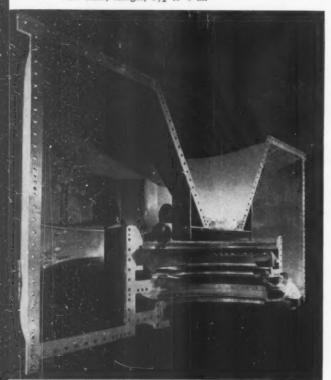
- To improve resistance to corrosion and caustic embrittlement.
- To improve machining stability and/or machinability of a weldment.
- To increase safety and service life of a welded structure or machine member.

Stress relieving is an expense. It should not be called for in design, particularly for large weldments, unless there is a valid reason to require the treatment.

Corrosion and Caustic Embrittlement

Stress relieving is used to improve resistance to corrosion only under special circumstances. If mild steel is to be exposed to a corrosive environment, the surface is usually protected by paint or other coatings. With one important exception, stress relieving does not significantly improve the resistance of mild steel to corrosion. Pressure vessels, boilers, and other equipment exposed to caustic solutions

Fig. 2—Fabricated cover for 300-mw steam turbine requires stress relieving to maintain stability after machining. Material is ASTM-A113 carbon steel. Plates are 1 to $1\frac{1}{2}$ in. thick; flanges, $2\frac{1}{2}$ to 4 in.



frequently develop caustic embrittlement and stresscorrosion cracking at local areas of high stress. This occurs in riveted as well as in welded vessels. Stress relieving to reduce the residual stresses caused by welding prevents caustic embrittlement, and for such applications, the treatment is definitely beneficial.

For resisting more severe types of corrosive conditions, stainless and corrosion-resistant steels are often specified in design. For these steels, stress relieving may be either ineffective or harmful. The straight chrome corrosion-resistant steels do not require stress relieving to develop full resistance to corrosion, but they are often given a heat treatment similar to stress relieving (after welding), to reduce hardness or to improve mechanical properties.

Austenitic corrosion-resistant steels are not improved by heating to normal stress-relieving temperatures. The stabilized types require no heat treatment after welding to make them corrosion resistant. Nonstabilized materials such as 18-8, which are adversely affected by welding, require a high temperature solution treatment, followed by proper cooling. Subjecting such steels to normal stress-relieving

Conclusions About Stress Relieving

- Stress relieving of mild steel is of little value for improving resistance to corrosion except where caustic attack may occur.
- To facilitate machining, stress relieving is unnecessary on mild steel but may be beneficial for weldments of air-hardening steels.
- Stress relieving to insure dimensional stability may be important for structures which require close tolerances but is unnecessary for most other weldments.
- As a safety measure, stress relieving is usually unnecessary and of no benefit as a preventive against failure due to static overload or to fatigue. However, for eliminating the hazard of low-stress brittle fracture, stress relieving is necessary.
- Spontaneous failures (cracking during fabrication) are a type of brittle fracture.
- Stress relieving of a heavy, rigid structure may be necessary before the weldment cools. Sometimes intermediate stress relieving is also necessary.
- For less rigid structures which can be safely manufactured without cracking, stress relieving should be specified if the structure is to operate at temperatures below the transition temperature of the material. If the structure is to operate at elevated temperatures and is not to be loaded at low temperatures, stress relieving is probably unnecessary.

temperatures sensitizes them and makes the entire surface vulnerable to corrosive attack.

High-nickel alloys and nonferrous alloys such as copper and aluminum do not require stress relieving to develop resistance to corrosion. Stress relieving of these materials is usually not recommended.

Machinability and Stability

Welding low alloy or other air-hardening steels may produce hard zones which make machining to accurate dimensions difficult. Heating to stress-relieving temperatures softens the hardened zones sufficiently to make machining satisfactory. In such cases, the primary benefit is due to softening the material rather than to eliminating residual stresses.

Structures which must maintain a high degree of dimensional stability frequently require stress relieving before machining, Fig. 2. Residual stresses caused by welding form a balanced system and machining may unbalance the system by removing material containing residual stresses; consequently, warping may occur during machining or in service. When machine tool frames and other structures requiring close tolerances and stability are fabricated by welding, stress relieving before machining is usually advisable.

However, not all weldments which must maintain stability need to be stress relieved. For example, close tolerances were required on the blowers used in the Oak Ridge installation of the Manhattan Project, but they were not stress relieved after fabrication. These units were single-stage, centrifugal blowers with spiral-type casings, which were fabricated from two essentially similar pressed parts welded around the outer periphery of the spiral. A large opening at one side was closed by a cover bolted to a flange which was welded to the side of the casing with two full-girth welds.

That part of the casing which had to remain true after machining was the face of the bolting flange because only metallic gaskets were permissible. Since the welds around the flange were symmetrical, the assumption was made that they would not cause a waviness in the flange face either during machining or later on in service. Although the weld around the outer periphery was not symmetrical, the distance from the flange face was large enough that any movement after machining seemed unlikely. The conclusion was against stress relieving. Inspection and service records show that no warping occurred either during machining or in service.

When doubt exists as to whether or not stress relieving is required, the heat treatment is often specified as a safety precaution. However, such a decision in the case of the blowers would have been costly. Fig. 3 is another example where stress relieving was unnecessary.

Weldment Life and Safety

For the great majority of weldments, the intended purpose of stress relieving is increased safety of the structure and insurance against premature failures

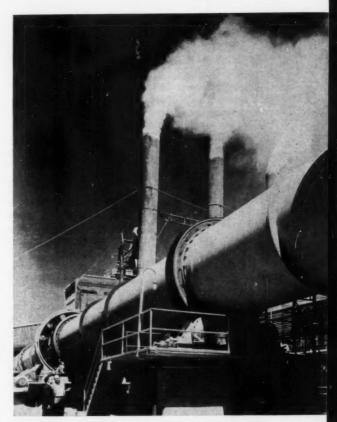


Fig.3—Lime kiln shell is an example of a large ASTM-A113 carbon steel weldment that required no stress relieving to maintain satisfactory stability. Shell thickness is 3/4 in. Ring sections are 2 in. thick. The transition course is 11/4 in. thick. Shell is lined with refractory material to handle lime at temperatures of 1700 to 2400 F.

(including failure by cracking during fabrication). Sometimes, stress relieving is specified for structures subjected to repeated loads, on the assumption that fatigue resistance is increased. However, stress relieving does not always increase fatigue resistance and, under some circumstances, it reduces the fatigue strength of welded structures.

Furthermore, structures are often stress relieved unnecessarily. This situation may come about for various reasons. For example, a weldment of a new design may be stress relieved merely as a safety precaution. Later, stress relieving is continued in routine production without further consideration of the real need for it.

Heat-treatment specifications and company standards sometimes require stress relieving of weldments on a basis of accepted shop procedure rather than on design studies to meet requirements.

A logical conclusion as to whether or not stress relieving is necessary, or advisable, can be reached by considering the effects of stress relieving on each of the most common types of failure.

• Types of Failure

Failure of a weldment is usually due to one of

three types of loadings:

- Static loads which stress the part beyond its ultimate strength.
- Repeated loads which stress the material beyond its endurance limit,
- A combination of loading and temperature conducive to brittle fracture.

Static Failures: Residual stresses are not a factor in the rupture of a weldment in which static loading sets up stresses exceeding the ultimate strength of the material. For example, when a structure is loaded statically in tension, the tensile stresses due to the load and any residual tensile stresses are additive up to the point where the combined stress reaches the tensile yield point of the material. Beyond this point, additional load causes local plastic deformation, which shifts the load from the areas of high stress to areas of lower stress until finally the entire section reaches the yield point. Thus, residual stresses are relieved locally and the weldment behaves in the same manner as though no residual stress had been present originally.

Under certain circumstances, stress relieving may reduce the static load-carrying capacity of a structure. Test reported by the Standard Oil Company of Indiana1 showed that the bursting strength of cylinders made of welded pipe which had not been stress relieved was as much as 10 per cent higher than the strength of similar pipes which had been stress relieved. The reduction in strength was due, not to the removal of residual stresses by the stressrelieving treatment, but to the softening of the material and the weld. During the forming operation, the plate material used in fabricating the pipe was cold worked to a certain extent, which raised its ultimate strength. Stress relieving removed most of this work hardening. Also, because weld metal in the as-deposited condition normally has a somewhat higher strength than it has after stress relieving, the stress-relieved pipes were weaker than the as-welded ones.

Failure Under Repeated Load: In structures subjected to repeated loading, residual stresses produced by welding are generally not harmful. The explanation of the apparent anomaly is that the first few cycles of stress under an application of repeated load reduce original residual stresses to such a large extent that the remaining residual stresses have no pronounced effect. The higher the stresses of repeated load, the greater is the reduction of the residual stresses.

Brittle Fracture: The third type of failure which must be considered in deciding whether to stress relieve is low-stress brittle fracture. This type of failure, almost unknown prior to 1940, was brought forcibly to the attention of the welding industry by failures of welded ships during and after World War II. Although such failures in structures other

than ships had occurred prior to that time, they attracted no particular attention and were not classified as brittle fractures. Among the non-ship structures which failed in this manner were bridges and storage tanks.

Brittle fracture differs from ordinary static failure in that brittle fracture occurs at low stresses, often at less than half the yield strength of the material, and in a sudden manner without warning. Stress relieving is of vital importance in the prevention of brittle fracture of weldments, Fig. 4.

• Preventing Brittle Fracture

Research programs to determine the causes of low-stress brittle fractures and methods of preventing them have not been wholly satisfactory. A difficulty has been to obtain failures in the laboratory at the relatively low stresses to which structures in service were subjected at the time of their failures. Recently, however, both English² and Japanese³ investigators have succeeded in producing low-stress brittle failures under laboratory conditions. Although numerous questions still remain, the opinion of many investigators now prevails that brittle fracture occurs only if and when three conditions are present simultaneously:

- The steel is in a notch brittle condition because of low temperature.
- 2. A crack, notch, or some type of defect exists within the structure.
- A high residual tensile stress exists in the region of the notch.

To prevent brittle fracture, it is necessary to remove only one of these conditions. Which condition can be most easily eliminated depends upon circumstances.

Notch Brittle Steel: It might appear that the simplest solution would be to avoid the use of a material which is notch brittle. Indeed, that would be a desirable solution, but few commercial grades of mild steel are available which are not susceptible to brittle failure within the temperature range to which many structures are subjected. Bridges, tanks, and ships, built of standard grades of mild steel have developed brittle fractures at ambient temperatures.

Special steels are available which remain tough at low temperatures but these materials are too expensive for general use. The problem is further complicated because no universally accepted test exists for determining whether a steel can be used for a given application without the danger of brittle fracture.

Standard and special tests such as Charpy tests with various modifications, slow-bend tests, tear tests, Pellini drop-weight tests, and others have been used to determine "transition temperatures." However, these tests give different values for transition temperatures and there is no conclusive evidence as to which, if any, of the tests indicate the temperature at which a steel becomes susceptible to brittle fracture in service. Eventually, a satisfactory test may be found which will indicate the minimum tem-

References are tabulated at end of article.

perature at which a given grade of steel can be used with safety.

An ambient temperature of 100 F is recognized as a minimum for which brittle fracture of mild steels would not be a problem. Thus, for equipment which operates at elevated temperatures, brittle fracture in service is not a hazard.

Flawless Fabrication: Insurance against brittle fracture by fabricating welded structures without cracks or defects is a worthy goal, but rather difficult of attainment. New inspection methods make the detection of defects easier than previously, but there is a question as to whether even the most care-

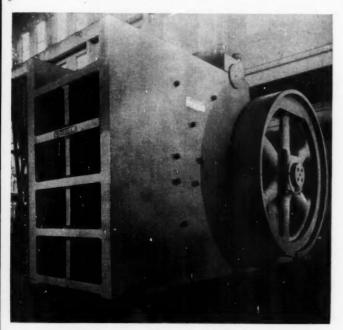


Fig. 4—Heavy rigid structure for 42 by 48 in. jaw crusher required stress relieving before cooling to prevent spontaneous brittle fracture during cooling. Side plates are 6 in. thick.

ful inspection can detect all significant flaws. In some brittle fractures, pinpointing the defect to which failure could be definitely attributed has been difficult.

By relying upon thorough inspection and careful workmanship to remove all possible defects, some large construction projects have been successfully completed and put into service. However, success in these instances is not conclusive evidence that all defects were eliminated. It indicates with certainty only that not all the factors required to cause brittle fracture were present simultaneously.

Residual Stress Removal: Stress relieving a weldment in a furnace is the most common way to remove residual stresses. Thermal stress relieving has proved very effective inasmuch as there are no known instances of low-stress brittle fracture of structures which have been furnace stress relieved.

The service record is confirmed by the findings of investigators who are studying this problem, particularly those in England and Japan. They have found that although as-welded specimens (which contained an intentional defect) failed in a brittle manner at temperatures of 10 F or higher, similar specimens, stress relieved at 1200 F, did not develop brittle fracture when tested at temperatures as low as -60 F.

Further evidence that the elimination of residual stresses prevents brittle fracture is furnished by the English² and Japanese^{3, 4} reports. Investigators in both countries prestressed as-welded specimens to the yield point, at a temperature above the transition temperature, before testing them at a low temperature. (Stressing the material to the yield point is a recognized method of stress relieving.) When the prestressed specimens were tested at temperatures as low as -60 F, brittle fracture did not occur.

Word of Caution

Many pressure vessels and other structures are fabricated in accordance with the rules of the ASME Boiler Code or one of the state codes. In such cases, the requirement of the governing code with respect to stress relieving must be met. An engineer in charge of a project has no option in regard to stress relieving.

It is suggested that in future revisions of these codes the requirements for stress relieving be reconsidered. The latest edition of the ASME Code (1959) requires stress relieving for mild-steel vessels fabricated of material over $1\frac{1}{4}$ in. thick for operating temperatures above -20 F. For operating temperatures below -20 F, special steels are specified.

Stress relieving all vessels having wall thicknesses over 1½ in. is certainly safe. But, is the expense of stress relieving justified for all structures operating at warm to elevated temperatures, and which are well above the transition temperature of the steel?

The practice of omitting stress relieving structures of mild steel under $1\frac{1}{4}$ in. thickness is questionable.

Many, if not most, of the brittle fractures which have occurred in service have been in materials of 1-in. thickness or less. Failures have occurred in these structures below room temperatures, but at temperatures well above $-20\,\mathrm{F}$ which is considered the threshold of low-temperature service. In view of service performance and available data from laboratory tests, how can a criterion for stress relieving be based on thickness alone, disregarding the temperature at which the structure is to operate?

REFERENCES

- L. J. Prevoznik—"Effect of Stresses on Strength of Circumferentially Welded Cylinders," The Welding Journal, Vol. 31, No. 12, Research Supplement, 1952, pp. 587s-595s.
- R. Kennedy—"The Influence of Stress Relieving on the Initiation of Brittle Fracture in Welded Plate Specimens," British Welding Journal, Vol. 4, No. 11, November, 1957, pp. 529-534.
- H. Kihara and K. Masubuchi—"Effect of Residual Stresses on Brittle Fracture." The Welding Journal, Vol. 38, No. 4, Research Supplement, 1959, pp. 1599-168s.
- H. Kihara, K. Masubuchi, and H. Ishii—"Brittle Fracture Strength of Welded Spherical Container," The Welding Journal, Vol. 38, No. 11, Research Supplement, 1959, pp. 451s-456s.

When an inventor alters the claims during his patent application, his rights to legal action later may be blocked by

patent pitfall—

File-Wrapper Estoppel

ALBERT WOODRUFF GRAY

Forest Hills, New York

ANY patents go through the patent office without a hitch. Some do not. If problems arise during negotiations with the patent office, the inventor may have to redefine or abandon certain of his claims in a compromise to obtain his patent. When this condition occurs, he is barred, or estopped, from later reclaiming the abandoned feature or their equivalents as part of his patent monopoly. This legal barrier to future action is called filewrapper estoppel.

A PPLICATION for a patent contained the word "convoluted" in its claims. The patent examiner objected to the use of this word and suggested the word "accordion" be substituted in its place,

Apparently as a compromise the inventor added the definition, limiting the scope of his claim: "... folded in curves or tortuous sinuous windings, that is, bending in and out in serpentine, wavy or accordion folded form."

Later, when this patentee charged infringement against the manufacturer of another similar product that was convoluted, he was met by this estoppel record made by the patent examiner on the file wrapper of his application. In holding that the original inventor was thus estopped by the modifications he had made in his patent application, the court said,

"The doctrine of file wrapper estoppel depends upon the fact that when an applicant has accepted a rejection of a broad claim, he may not later assert that another claim, deliberately rerestricted to obtain its allowance, is its equivalent. If this inventor wished to insist upon all kinds of 'convolutions' which might result from high pressure he was not free to abandon haphazard 'convolutions' and then to assert that the claim covered them."

W HEN an inventor abandons certain patent claims on the features of an invention, this action is often referred to as a disclaimer. The law relating to estoppel resulting from a disclaimer was spelled out in an earlier case before a federal appellate court. There the defense of file-wrapper estoppel had been interposed to a suit brought for the alleged infringement of electrical equipment.

The device as described in the claim was, "In a coupling for spirally wound flexible conduits, a tubular member having means at one end adapted to be affixed to the wall of a junction box or the like, the other end of said coupling being insertable within the end of the conduit

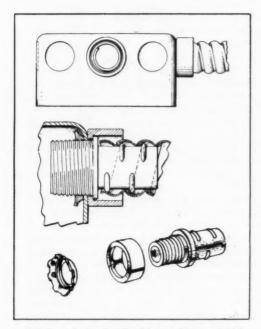
References are tabulated at end of article.

and having a series of ribs extending at substantially right angles to the major axis of said tubular member and adapted to engage the convolutions of the conduit, said ribs being sequentially disposed in staggered relation along the outer surface of the conduit-engaging portion of said coupling so as to define a spiral having a greater helical angle than the normal helical angle of the conduit."

The essential, and almost the only, difference between this invention and the alleged infringing device was the location of the ribs. Ribs of the device alleged to be infringed were at 90 deg to a major axis while the ribs of the infringing device were at from 85 to 89 deg with

the major axis.

In the original application nineteen claims had been set out. All were rejected by the Patent Office. Amended claims had then been submitted for "ribs extending substantially at



Coupling device for flexible conduits on which original patent application was rejected by Patent Office. Patent was finally issued when the inventor submitted amended claims for "ribs extending substantially at right angles to the major axis of said tubular member." Later, the inventor brought suit for infringement against another device which was almost identical to his design except for the angle (85 to 89 degrees) of the ribs with the major axis. Court ruled there was no infringement since the inventor had forfeited, by file-wrapper estoppel, any right to an exclusive claim on this design feature.

right angles to the major axis of said tubular member," and were allowed.

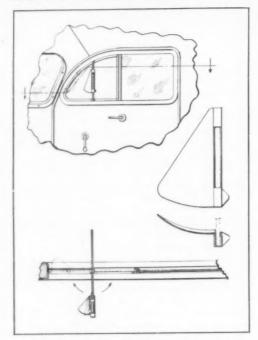
In holding the patentee had forfeited by estoppel any right he might have against infringement of this feature, the court said: "Thus the file wrapper history unmistakably shows that the novel feature claimed by the inventor was the right angular position of the 'ribs' of the device. It was only by the most earnest and aggressive argument that patentability was secured by distinguishing this feature from the interrupted screw threads contained in the prior art. It is immediately apparent that since, as urged by the inventor, the ribs of the patented article in suit perform a function entirely different from that of screw threads, the right angularity of the ribs is critical, since to allow even a slight regular variation would be to lose the principle claimed for it by causing the ribs to become mere convolutions of a screw thread. Having asserted the novelty of the right angle principle in order to secure the patent, the patentee cannot now expand his coverage to include other claims which were denied him in the proceedings before the Patent Office."2

THE term "equivalents" as used in the patent law, was defined by one of the federal courts as: "An equivalent as used concerning patents is a thing which performs the same function in substantially the same manner as the thing of which it is alleged to be an equivalent."

As substitutes, equivalents are, of course, also affected by patent claims, or their disclaimer or abandonment, and cannot subsequently be reclaimed by the inventor as being within his patent monopoly. This feature of file-wrapper estoppel played a major role a few years ago in a legal controversy. Here, the inventor had forfeited his right to a patent monopoly by his disclaimer or repudiation of a claim made at the time of the issuance of his patent.

The subject of that patent, as described in the claim relied on in this action, was an air deflector for use upon vertical pivoted ventilators and formed from a single sheet of material: "Said deflector comprising a body portion of concavo-convex formation and conforming to a frustro-conical segment, one edge of said body portion terminating in an attaching channel of U-shape, open upon one side, the said channel having its opposite closed side slotted for the reception of the firm member of the ventilator and means integral with said channel for removing the deflector."

The alleged infringing invention was the subject of the comment by the court that, "Admittedly the accused structure is almost an exact



Automobile air-current deflector which was patented after long negotiation with Patent Office, involving several changes in the inventor's claims. Some time after the patent had been issued, an almost exact duplicate of this design was brought on the market by another company. In the subsequent legal action, the court ruled that the patent had not been infringed. Because of the circumstances under which the patent claims were accepted, "the patentee is in no position to enlarge their scope or to assert their application in the general language which was rejected by the Patent Office. Neither can [he] . . . assert his claims against equivalents which might respond to his rejected claims but which did not respond to the claims as issued."

duplicate of the patentee's commercial structure." Then, of the file wrapper and the efforts made by the inventor to secure his patent, the court continued, "The file wrapper contents show that the inventor made rugged resistance in the Patent Office. Notwithstanding the purpose of his invention as well as the objective sought to be accomplished, were stated, his broad claims were disallowed in view of the prior art.

"In the first instance six claims were rejected by the Patent Office. These were cancelled by the inventor and three new claims substituted. These too, were rejected and cancelled. Two other claims were presented and these allowed, one of these the basis of this action.'

Of the consequences of these events, the court concluded: "Under the circumstances attending upon the procurement of the claims, the patentee

is in no position to enlarge their scope or to assert their application in the general language which was rejected by the Patent Office, over the prior art. Neither can the patentee under such circumstances assert his claims against equivalents which might respond to his rejected claims but which did not respond to the claims as issued."3

OVER a quarter of a century ago the U.S. Supreme Court described the effect of a disclaimer in a patent application on the inventor's right to defend the patent subsequently issued against equivalents. In later decisions on controversies of this character, repeated references to this decision have served to make it a basic rule today, governing the effect of filewrapper estoppel in such situations.

"It is well settled," said that court, "that where an applicant for a patent to cover a new combination, is compelled by the rejection of his application by the Patent Office, to narrow his claim by the introduction of a new element, he cannot after the issue of the patent broaden his claim by dropping the element which he was compelled to include in order to secure his patent.

"If dissatisfied with the rejection he should pursue his remedy by appeal and where in order to get his patent, he accepts one with a narrower claim, he is bound by it. Whether the examiner was right or wrong in rejecting the original claim the court is not to inquire.

"The applicant, having limited his claim by amendment and accepted a patent, brings himself within the rule that if the claim to the combination be restricted to specified elements all must be regarded as material and that limitations imposed by the inventor, especially such as were introduced into the application after it had been persistently rejected, must be strictly construed against the inventor and looked upon as disclaimers.

"The patentee is therefore estopped to claim the benefit of his rejected claim or such a construction of his amended claim as would be equivalent thereto. So where an applicant whose claim is rejected on reference to a prior patent, without objection or appeal, voluntarily restricts himself by an amendment of his claim to a specific structure, having thus narrowed his claim in order to obtain a patent, he may not by construction or by resort to a doctrine of equivalents, give to the claim a larger scope, which it might have had without the amendments which amount to a disclaimer."

REFERENCES

- Tampax, Inc. v. Personal Products Corp., 123 Fed. 2d 722, N. Y., Nov. 24, 1941.
 D. & H. Electric Co. v. M. Stephens Mfg., Inc., 233 Fed. 2d 879, Cal., Mar. 28, 1996.
- Peters & Russell, Inc. v. Dorfman, 188 Fed. 2d 711, Ill., Apr. 27, 1951.
- 4. I.T.S. Rubber Co. v. Essex Rubber Co., 272 U. S. 429, Mass., Nov. 22, 1926.

Pressure Loss Factors for

Internally Linked Bellows Joints

C. M. DANIELS

Supervisor

and

R. E. FENTON

Senior Research Engineer Rocketdyne Div. North American Aviation Inc. Canoga Park, Calif.

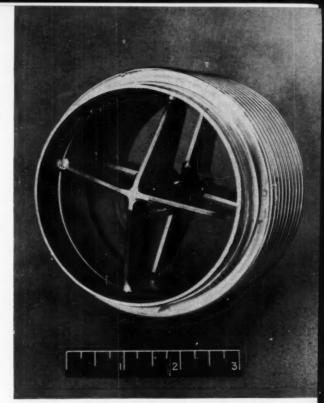


Fig. 1—Chain-type construction with four cross webs may weigh less than gimbal-ring construction with two webs, but loss factors are greater. Compare curves of Fig. 2 and 3.

BELLOWS joints of the internal link type are simple, compact, sturdy, and streamlined on the outside. They are usually lighter in weight than other flexible bellows joints. They are suited especially for use in aircraft and missiles provided the relatively high pressure losses can be accommodated in the ducting system.

Two internally linked joints are in common use: The chain-link type, Fig. 1 and 2, and the gimbal-ring type, Fig. 3 and 4. This article presents experimentally obtained loss factors for fluid flow in these two types of joints.

Data for the chain-link type are correlated by

Nomenclature

- A_D = Duct cross sectional area upstream of joint, in.²
- $A_N = Minimum$ free flow area in joint, in.²
- $g = \text{Acceleration of gravity, 386 in. per sec}^2$
- K = Loss factor
- $= \Delta p/q$
- q= Velocity head based on duct area, psi
 - $= \rho v^2/2g$
- v = Mean velocity of flow medium based on duct area, in. per sec
- $\Delta p = \text{Total pressure loss of joint, psi}$
- ρ = Density of flow medium, lb per in.³

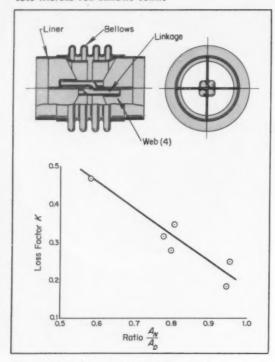


Fig. 2—Plot of points obtained from chaintype joints of different sizes provides curve of data suitable for use in duct design.

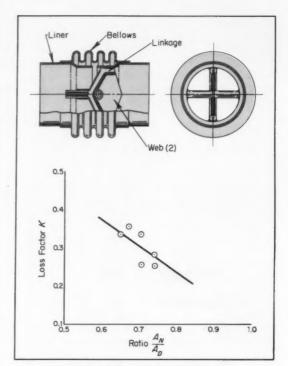


Fig. 3—Gimbal-type joints have notably lower loss factors than chain-type joints of equivalent ratios.

Fig.	Factor K	$\frac{A_N}{A}$	Thickness of Web (in.)	Diameter of Link (in.)	Lie	er No	Nominal ID (in.)
140.	A	AD	or wen (m.)	Link (m.)	169	MO	ID (III.)
2	0.468	0.582	0.093	0.187	x		1%
2	0.182	0.945	0.032	0.125		x	21/4
2	0.247	0.953	0.026	0.125		x	21/4
2	0.315	0.778	0.064	0.310	×		3
2	0.346	0.806	0.036	0.225	x		31/4
2	0.278	0.796	0.047	0.380	x		4
3	0.357	0.676	0.025	0.125	×		1%
3	0.335	0.646	0.040	0.250	*		21/4
3	0.336	0.702	0.040	0.250	×		3
3	0.255	0.702	0.040	0.250	x		3
3	0.283	0.740	0.040	0.250	x		31/4
3	0.252	0.740	0.040	0.250	×		314

plotting loss factor $K = \Delta p/q$ as a function of netflow area to duct-area ratio, Fig. 2 and 3. See Nomenclature. Typical joint dimensions with corresponding loss factors K are given in Table 1. Curves through the plotted data represent a mean value of K over a range of flow rates.

Loss factor is practically independent of Reynolds' number over the range from 60,000 to 800,000 but is dependent on the particular design used. Loss factor is inversely proportional to the mini-

mum free-flow area, Fig. 2 and 3.

Data for the unlined joints are converted to equivalent data for lined joints by the method described in the reference.*

The gimbal-ring type exhibits lower pressure loss than the chain-link type, Fig. 3. It is usually heavier because of the gimbal ring required to with-

[°]C. M. Daniels and R. E. Fenton—"Determining Pressure Drop in Flexible Metal Hose," Machine Design, Vol. 32, No. 21, October 13, 1960, pp. 195-198.

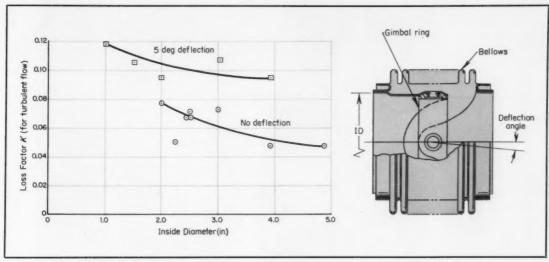


Fig. 4-Loss factors in gimbal-ring joints are appreciably greater when joints are bent.

stand the pressure separating load. This pressureloss factor is plotted in Fig. 4 as a function of joint inside diameter.

Although some of the data were obtained with air as the flow medium and some with water as the flow medium, the loss factors may be used interchangeably in duct-loss calculations providing the air-flow velocities are not in a range where compressibility must be taken into account. This state normally exists where the pressure downstream of a joint is not less than 90 per cent of the pressure upstream.

Tips and Techniques

Calculating Gear Teeth

The following method can be used to calculate the number of teeth in a two-set gear train where the ratios are simple and the same pitch is used in both gear sets. The method is especially suited to calculating teeth for a two-set reverted gear train to give the most compact arrangement. An example will illustrate the procedure.

Example: Assume that required train ratio R=1/10. The best solution is one in which both driving gears are almost the same size.

The nearest integral number to the square root of 10 is 3. From this,

$$R = \left(\begin{array}{c} 1 \\ \hline 10 \end{array}\right) \left(\begin{array}{c} 3 \\ \hline 3 \end{array}\right) = \left(\begin{array}{c} 1 \\ \hline 3 \end{array}\right) \left(\begin{array}{c} 3 \\ \hline 10 \end{array}\right)$$

Next, add the numerator and denominator of the second form of the equation, 3 + 1 = 4 and 3 + 10 = 13. Then, "cross-multiply":

$$\frac{1}{3} \times \frac{13}{13} = \frac{13}{39}$$
 and $\frac{3}{10} \times \frac{4}{4} = \frac{12}{40}$

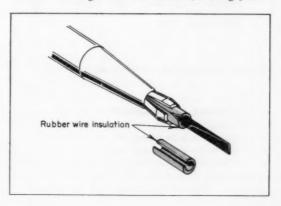
The required gears are, then, (13/39) (12/40) or any multiple of these numbers. If a closer similarity between driving gears is required, 3.2 can be substituted for 3, since it is closer to (10)½.

If the numerator or denominator of the train

ratio, R, is not an integer, simply multiply numerator and denominator by a number such that the working ratio contains two integers. For example, if R=17.5:1, multiply by 2 to give R=35:2.— Einar T. Young, Sun Oil Co., Newtown Square, Pa.

Pencil-Lead Cushion

A small piece of rubber wire insulation, slit as shown in the illustration, can be used to protect the lead in a mechanical drafting pencil. The cushion allows a greater pressure to be applied to the lead without breakage.—Frank H. Sutz, Chicago, Ill.





Thermofusion - a new molding technique

for fabricating... Large Plastic Parts

A European development, Thermofusion was introduced to this country in 1959 when license to the process was acquired by the Spencer Chemical Co. Present sublicensees are: American Agile Corp., Amos - Thompson Corp., Rubbermaid Inc., and Space Structures Inc.

FRANK J. BOCKHOFF

Associate Director Research & Development American Agile Corp. Maple Heights, Ohio RIOR to the recent introduction of the Thermofusion molding technique, most large plastic fabrications were welded from sheet and tube stock. Welded fabrications, although economical for one or a few items of a given type, are relatively costly for large quantities. Extrusion and injection molding are also used to fabricate fairly large items, but size of such parts is limited by the size of mold and injection-molding equipment. The patented Thermofusion process requires a minimum of manual labor and has considerably fewer limitations in size of finished parts than the molding processes.

The Process

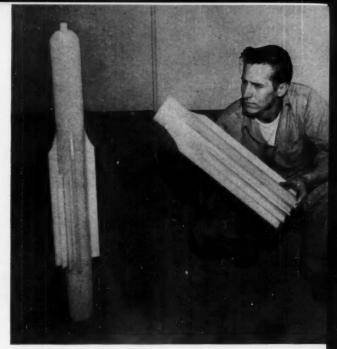
Molds required for the Thermofusion process are usually fabricated from light-gage sheet steel, rolled or formed to the outside shape of the part to be made. Size of molds is limited only by physical capacity of the oven equipment used for the process.

Close temperature control is required so that the powdered materials are uniformly fused on the interior mold surfaces. Unfused powder can be re-used. Wall thickness is controlled by temperature and time of exposure.

Because of low mold costs, advantages of the process lie in its adaptability both to large parts and to short-run items. Also, because the process does



Polyethylene tank of 250-gal capacity weighs only 74 lb, including cover and welded fittings. Wall thickness is 1/4 in.



Hollow polyethylene molding is used as a core in casting solid-propellant material for rocket motors. Wall of cylinder is 3/32 in. thick; fin walls are 1/8 in. thick.

not require high pressures common to other thermoplastic production methods, Thermofusion products are virtually stress-free.

Materials

Polyethylene is the only material presently being used on a commercial scale in Thermofusion products, although other powdered plastics such as nylon, cellulose acetate butyrate, and polypropylene may eventually share the market. These polyethylene products offer such features as light weight, clean hygienic quality, product uniformity, abrasion and chemical resistance, and availability of custom design at reasonable cost.

Properties of branch-type polyethylene fabricated by Thermofusion, Table 1, do not differ appreciably from the properties of polyethylene in parts produced by injection molding or compression molding. Excellent stress-crack resistance and low brittleness temperature, important properties in process equipment, can be readily attained.

Higher-density polyethylenes are also used in this process. The major differences in the final product are improved yield strength, significantly greater stiffness in flexure, and a somewhat higher temperature resistance.

Design

Size of finished parts is limited only by mold and auxiliary equipment size. Present commercial equipment accommodates the fabrication of tanks with capacities up to 500 gal. Wall thicknesses are generally uniform and can be specified in the range of 1/16 to $\frac{3}{8}$ in. Wall thicknesses in excess of

Table 1—Properties of Low-Density Polyethylene Fabricated by Thermofusion

Property		ASTM Test Procedure
Density at 23 C		16 800 80,000
(gm per cu cm)	0.919	D1505-57T
Stress-Crack Resistance at		
50 F (hr)	400+	D1693-59T
Stiffness in Flexure (psi)	13,100	D747-58T
Impact Strength Izod at		
73 F (ft-lb per in.)	No break	D256-56
Shore Hardness	D45	D1484-59T
Brittleness		
Temperature (F)	-103	D746-57T
Softening Point, Vicat (F)	205	D1525-58T

3/8 in. have not yet been developed satisfactorily. Tolerances on wall thickness can be held to plus or minus 1/32 in.; on length and diameter dimensions, to plus or minus 1/16 in.

Certain sections of moldings—tank rims, for example—can be reinforced by using techniques involving additional localized heating. Strength also can be increased by the use of ribs, or by incorporating metallic or nonmetallic framework in the parts.

Part exteriors can be tapered or stepped, but sharp or deep undercuts which may cause stresses in the finished item should be avoided. To reduce the possibility of stresses being introduced during cooling, corners should have minimum radii of 1/4 in. whenever possible.

Smoothness of exterior surfaces of parts produced by Thermofusion is governed entirely by smoothness of the mold in which the item is made. Interior smoothness, on the other hand, is determined by processing variables, particularly temperature and time. Interior surfaces generally have a matte finish.

Applications

Thermofusion is presently used extensively for the production of a wide range of standard branched-polyethylene tanks with capacities up to 350 gal, although cylindrical tanks up to 450 gal and rectangular tanks up to 500 gal in capacity can be produced on a custom basis. The light-weight, natural-color polyethylene tanks are molded with heavy walls to provide the strength and rigidity required for long service under severely corrosive conditions. Such tanks are used in research work and light manufacturing, and for materials-handling and storage jobs in the textile, drug and pharmaceutical, specialty chemical, rubber, beverage, and metal-finishing industries.

In addition to tanks, applications include boat hulls, large bottles, glove boxes, forms for molding polyester and epoxy resins, ventilator and exhaustduct components, acid troughs, missile components, large loading funnels, and roof-ventilator shields.



Polyethylene tanks and exhaust hood provide maintenance-free system for corrosive liquids. Tanks are Thermofusion molded; exhaust hood and ductwork are welded.

Complex structures and insert moldings are entirely within the realm of present operation. Also, other materials, particularly the olefin polymers and copolymers, are being investigated for application to Thermofusion.

Tips and Techniques

Solving Oblique Triangles

When three sides of an oblique triangle are known, the angles can be easily found by the use of haversines. Thus, for the triangle shown,

hav
$$A = \frac{(s-b)(s-c)}{bc}$$
hav $B = \frac{(s-a)(s-c)}{ac}$
hav $C = \frac{(s-a)(s-b)}{ab}$

where

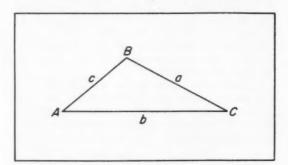
$$s = \frac{1}{2} (a+b+c)$$

If a table of haversines is not available, the following relationship may be used to determine the angle:

$$\cos \alpha = 1 - 2 \text{ hav } \alpha$$

where α is the angle to be found.

This method is considerably simpler than the one based on the law of cosines, and is especially easy to



use with a slide rule or with logarithms.—M. W. Loftus, Chicago, Ill.

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MacHINE DESIGN. Penton Bidg., Gleveland 13, O. Nomograms provide a quick, simple method for solving

QUADRATICS CUBICS QUARTICS

NOMOGRAMS provide definite advantages, in speed and convenience, over conventional methods of solving quadratic, cubic, and quartic equations. The following methods, based on nomograms, yield direct answers which are sufficiently accurate for many applications. Where a greater degree of accuracy is necessary, a procedure is given for refining the roots.

Any quadratic or cubic equation can be solved with these nomograms. The only limitation is in the method for quartics, which cannot be used if the equation has no real roots. But even here the method may be of some use, since it indicates whether or not a quartic has any real roots.

Quadratics

MERWYN E. ARTHUR

Staff Engineer Federal Systems Div. IBM Corp. Owego, N. Y.

$$x^2+bx+c=0$$

THIS nomogram may be used to solve any quadratic equation of the form $x^2 + bx + c = 0$. Those not in this form must be divided by the coefficient of x^2 .

Answers obtained from the nomogram are in two parts: k, which is one-half of the sum of the roots of the equation, and h, which is one-half of their difference. Thus, the roots are:

$$r_1 = k + h \tag{1}$$

$$r_2 = k - h \tag{2}$$

This method remedies the major disadvantage of many nomograms of this type: Diminishing accuracy as the roots come closer and closer to being equal.

For a given case, k may be either positive or negative, and takes the sign opposite to that of b. Since h may be either real or imaginary, the nomogram solves all quadratic equations, whether the roots themselves are real or complex.

The useful range of the nomogram may be ex-

tended by the use of either or both of the following methods:

1. With x = ny, divide the equation by n^2 . This yields

$$y^2 + \frac{b}{n}y + \frac{c}{n^2} = 0$$

where n is any convenient value that brings the constants within the range of the nomogram. Then, solve for y by aligning the straightedge through b/n on the b scale and c/n^2 on the c scale. Read k and h and find $y = k \pm h$. The values of $x(r_1$ and $r_2)$ are then equal to ny.

2. Let x = z - b/2. Then,

$$z^2 - \left(\frac{b}{2}\right)^2 + c = 0$$

Solve for z by aligning the straightedge through zero on the b scale and $[-(b/2)^2 + c]$ on the c scale. Since k must be zero, then $z = \pm h$, and $x(r_1)$ and $r_2) = -b/2 \pm h$. This substitution is most useful when the value of h is near zero; however, in many cases the preceding method must also be used to obtain an accurate reading.

Example 1: To solve $x^2 + 8.4x - 9.4 = 0$, align the straightedge with 8.4 on the *b* scale and -9.4 on the *c* scale. Then, k = -4.2 and h = 5.2. From Equation 1 and 2, $r_1 = 1$ and $r_2 = -9.4$.

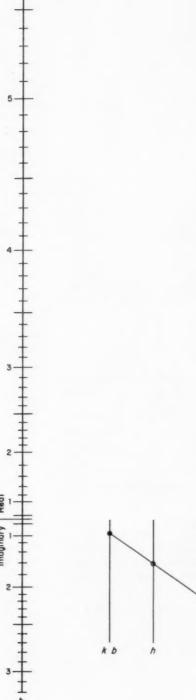
Example 2: To solve $x^2 - 12x - 45 = 0$, use method 1, with n = 3, to get $y^2 - 4y - 5 = 0$. Then, from the nomogram, k = 2 and k = 3. Finally, from method 1, k = 1 or k = 1, therefore k = 1 and k = 1. Equation 1 and 2.

Example 3: For $x^2 - 5.8x + 8.39 = 0$, k = 2.9, but h is too near zero. So, using method 2, x = z + 2.9 and $z^2 - 8.41 + 8.39 = z^2 - 0.02 = 0$. From method 1, with n = 1/10, or z = 1/10y, $y^2 - 2 = 0$. Align the straightedge through b = 0 and c = -2 and read h = 1.4. Then, $y = \pm 1.4$; $z = \pm 0.14$. Hence, $r_1 = 2.76$ and $r_2 = 3.04$.

Example 4: For $x^2 - 5.2x + 8.7 = 0$, align the straightedge through b = 5.2 and c = 8.7. Then, k = 2.6 and h = j1.4. The roots are $r_1 = 2.6 + j1.4$ and $r_2 = 2.6 - j1.4$.









Cubics

LEE E. DUNBAR

Research Specialist Grumman Aircraft Engineering Corp. Calverton, N. J.

$$x^3 + bx^2 + cx + d = 0$$

THE following nomogram provides a quick and simple method for extracting the real root from an equation of the general form $x^3 + bx^2 + cx + d = 0$. The ranges available from this method are adequate for most problems. If the equations being solved are descriptive of physical systems, it seems to be characteristic that "normalized" coefficients are not substantially larger than unity.

1. Beginning with an equation of the form $x^3 + bx^2 + cx + d = 0$, if d is negative, go directly to step 3, with x = y.

2. If d is positive, substitute y = -x, so that the equation then becomes $y^3 - by^2 + cy - d = 0$. This operation simply changes the sign of b and d.

3. Normalize the constant term to unity by choosing $\alpha = 1/d^{1/3}$, and letting $z = \alpha y$. This yields

$$z^3 + Mz^2 + Nz - 1 = 0 ag{1}$$

where $M = b\alpha$ and $N = c\alpha^2$. The signs of M and N

are like those of b and c when d is negative.

4. With the equation in the form shown in (1), draw a line between M and N on the nomogram. Read the real root, z, on the curved scale. To get the root of the original equation, simply work back through the x and y transformations. If greater accuracy is desired, the root may be refined by the use of Newton's Method (Example) before the root is divided into the original equation to obtain the reduced quadratic.

Example: Solve the equation $x^3 - 6.11x^2 + 4.44x + 3.308 = 0$.

1. To change the sign of the constant term, 3.308, set y = -x. From this, $y^3 + 6.11 y^2 + 4.44 y -3.308 = 0$.

2. Choose $\alpha = 1/(3.308)^{1/3} = 0.671$; $\alpha^2 = 0.450$.

3. Let $z = \alpha y$; then, $z^3 + 4.09z^2 + 2z - 1 = 0$.

4. From the nomogram, with M=4.09 and N=2.0, read the real root of the equation on the z scale, z=0.3.

5. Work back through the x and y transformations. Thus, $y=z/\alpha=0.3/0.671=0.447$; and x=-y=-0.447.

This value may be sufficiently accurate. However, if further refinement is necessary, use Newton's Method:

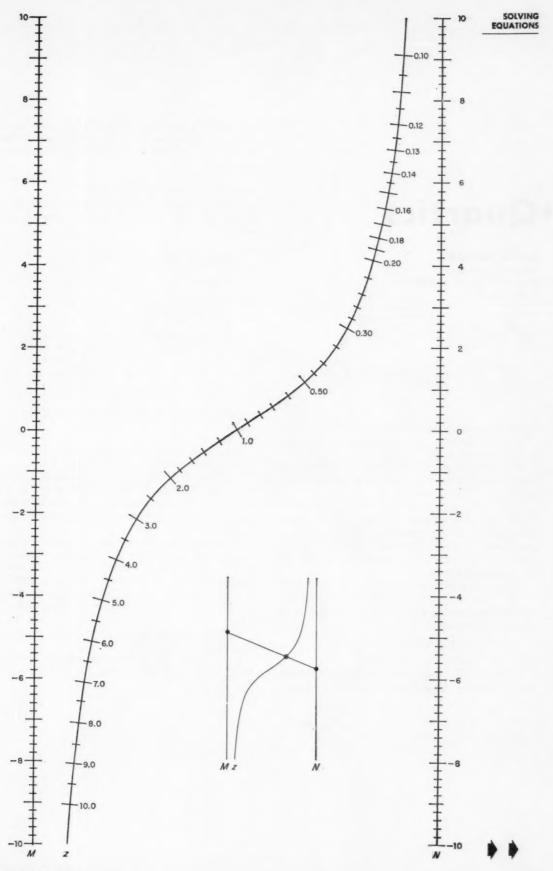
$$x_2 = x_1 - \frac{f(x_1)}{f'(x_1)}$$

where x_2 is a refinement of x_1 .

Using synthetic division, extract the root already known.

From this, $f(x_1)/f'(x_1) = 0.018/10.5$. Then, $x_2 = -0.447 - (0.018/10.5) = -0.449$. This procedure can be carried out to obtain any desired degree of accuracy.

6. Again using synthetic division extract the refined root, to give $x^2 - 6.559x + 7.385 = 0$. The reduced quadratic equation may be solved by the method outlined in the previous section to obtain the three roots of the equation: x = 5.116, 1.443, -0.449.



September 14, 1961

•Quartics

LEE E. DUNBAR

Research Specialist Grumman Aircraft Engineering Corp. Calverton, N. J.

$$x^4 + bx^3 + cx^2 + dx + e = 0$$

THESE nomograms, extensions of the one used for cubic equations, solve quartic equations of the general form $x^4 + bx^3 + cx^2 + dx + e = 0$.

Although this method is similar in accuracy and speed to the one used for cubics, it is not universally applicable. This is because the quartic may have two pairs of complex conjugate roots, whereas the cubic must have at least one real root. A further difference in the two methods is in the number of nomograms required: The quartic solution may use either of two nomograms, depending on the sign of the constant term, e.

1. Beginning with the general equation $x^4 + bx^3 + cx^2 + dx + e = 0$, normalize the constant term to unity by choosing $\alpha = 1/(/e/)^{1/4}$. With $z = \alpha x$, the equation becomes

$$z^4 + Mz^3 + Nz^2 + Pz \pm 1 = 0$$

where $M = b\alpha$; $N = c\alpha^2$; $P = d\alpha^3$.

Choose the appropriate nomogram, depending on whether the constant is plus or minus 1. 3. Strike a line from N to P; at the intersection with the appropriate M curve, drop perpendiculars to the z axis to obtain the positive roots of the z equation.

4. Divide each z value by α to obtain the posi-

tive roots of the original equation.

5. To obtain the negative roots of the equation, change the signs of M and P, and repeat steps 3 and 4.

Example 1: Solve the equation $x^4 + 569x^3 + 50,670x^2 - 7.80 \times 10^6x + 7.89 \times 10^7 = 0$.

1. Compute $\alpha = 1/(7.89 \times 10^7)\% = 1.057 \times 10^{-2}$; $\alpha^2 = 1.116 \times 10^{-4}$; $\alpha^3 = 1.18 \times 10^{-6}$.

2. Change the equation to $z^4 + 6.02z^5 + 5.65z^2 - 9.2z + 1 = 0$.

3. On the nomogram for positive e, strike a line from N=5.65 to P=-9.2. Drop perpendiculars from M=6.02, and find z=0.12 and 0.74.

4. To find the negative roots, change the signs of M and P, and perform step 3 with M=-6.02; N=5.65; P=9.2. This yields z=-2.7 and -4.0.

5. Divide each approximate root by α , giving x = 11.3, 69.9, -255, -378.

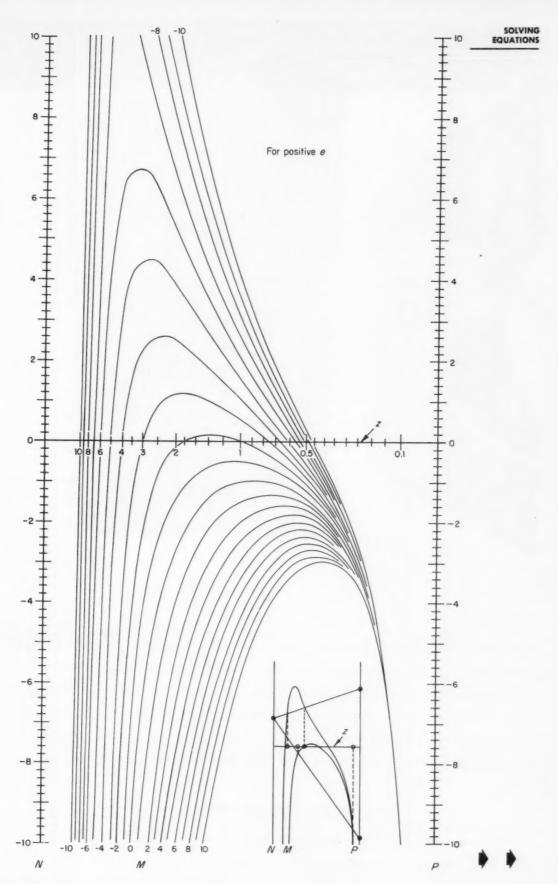
Example 2: Solve the equation $2.65x^4 - 21.5x^3 - 286x^2 + 8.46 \times 10^3x - 5.3 \times 10^4 = 0$.

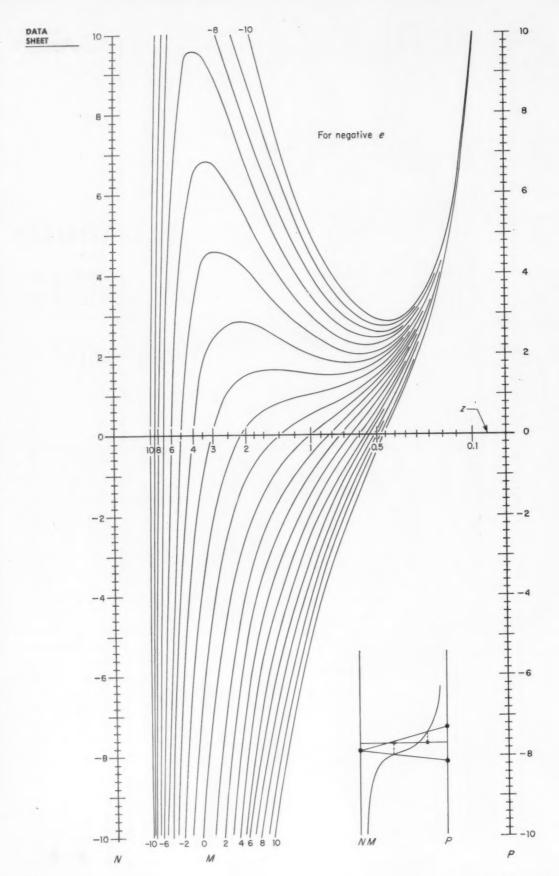
1. Follow the steps outlined in **Example 1** to get z=0.72. Change the signs on M and P to get z=-1.4. Since only the two real roots have been found, the other two roots must be complex conjugate.

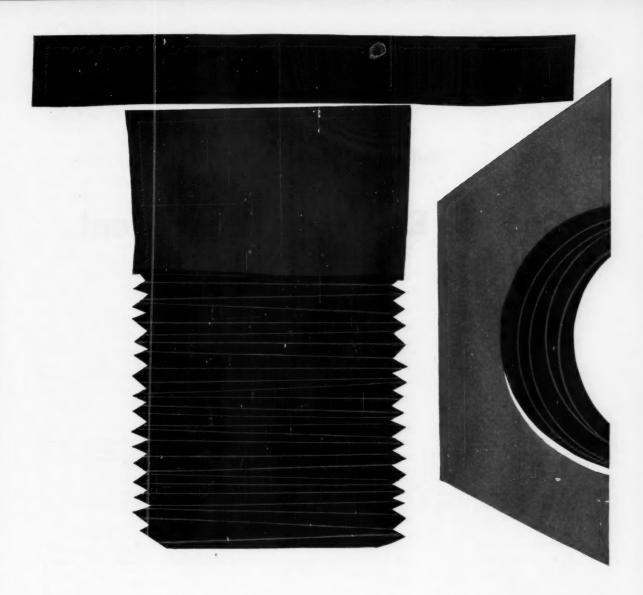
2. Refine the two known roots by synthetic division, as shown for cubic equation. Then, z_2 (for z=0.72) = 0.72+0.018/1.231=0.74. Using the reduced cubic, $z^8+0.06z^2-0.716z+1.360=0$, remove the root z=-1.4 and refine it. Then, z_2 (for z=-1.4) = -1.40+(0.26/4.99)=-1.25

3. The remaining quadratic may now be solved to obtain $z=0.64\pm \mathrm{j}0.781$.

4. To obtain the roots of the original equation, divide the z roots by α . Thus, $x = 8.8, -16.1, 7.62 \pm j9.3$.







imagineering is the bold new look at Screw & Bolt that says "infinite design capability." Imagination, coupled with engineering, has led to endless new product design developments in fasteners and other threaded parts. ■ Need a new design fastener or threaded part where standard shelf items just won't fit? Clip this ad to your letterhead and Screw & Bolt's sales engineers will put *imagineering* to work for you.



SCREW AND BOLT CORPORATION

OF AMERICA . P.O. BOX 1708, PITTSBURGH 30, PA.

Plants: Pittsburgh, Pa. Gary, Ind. Southington, Conn. Norristown, Pa. • Warehouses: Portland, Ore. Denver, Colo. Atlanta, Ga.

Imagineering... for greater fastener progress

Selection of methods for

Cooling Electronic Equipment

W. E. KRAUSS

The Martin Co. Orlando Div. Orlando, Fla.

IN the selection of a cooling method for an electronic package, perhaps the most important factor is the intended use of the equipment. Basic differences characterize cooling systems and cooling techniques for ground, airborne, and space applications. The electronic equipment itself may strongly influence the choice of cooling method. In the future, solid-state equipment will require different cooling techniques than present equipment. Table 1 indicates the effectiveness of some of the heat-transfer modes discussed here.

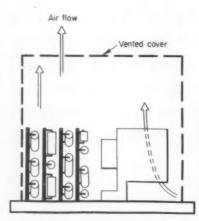


Fig. 1—Natural convection through vented cover.

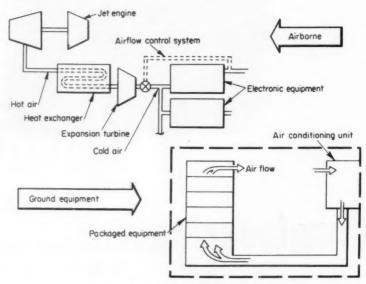


Fig. 2-Forced air cooling system.

Natural convection, Fig. 1, is probably the most commonly employed cooling technique. Frequently, it involves no thermal design because the equipment packaging density is low, and free or natural convection is adequate. With effective thermal design, natural convection can adequately cool electronic equipment having heat dissipations of 0.25 w per sq in. of cooling surface.

Natural convection occurs where masses of fluid are moved due to density variation caused by localized warming of the fluid. Coefficients of heat transfer for air are low, the order of magnitude being 0.2 to 1.25 Btu/(hr)(sq ft) (deg F).

Although natural convection is the predominant mode of heat transfer, radiation and conduction also occur concurrently.

Forced convection is more effecttive than natural convection in that the movement of air over the heatdissipating part is induced by a pressure source.

Forced movement of the cooling fluid causes a greater velocity—hence, a higher heat-transfer coefficient—to occur at the heat dissipating element. Forced - convection heat-transfer coefficients four to six times as great as those common in natural convection can be obtained. Forced convection should be used for heat dissipation not exceeding 2 w per sq in. of cooling surface.

When forced convection is utilized, a mechanical cooling system usually is involved. Depending on the application (airborne or ground installation), this includes: A cooling or refrigeration package, a pressure source (blower or compressor), a duct or distribution system, and some sort of temperature or airflow control. This system can become quite complex and may involve considerable auxiliary equipment, Fig. 2.

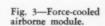
A good example of efficient thermal design is shown in Fig 3. The object is a module from a forced-cooled airborne computer. Note the series-parallel cooling path. Exhaust air temperature is approximately 225 F.

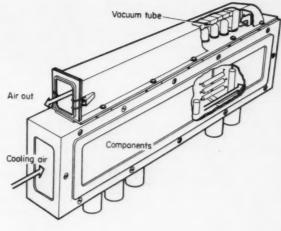
Radiative cooling is not commonly employed as the sole method for cooling since relatively high component temperatures are required for effective heat transfer. In some cases, however, radiative cooling is used to supplement other cooling techniques. For example, tube shields are normally blackened to increase their ability to absorb radiant energy.

Thermal radiation is emitted by bodies in the form of electromagnetic waves of various wave lengths, and radiation will travel through a

Table 1—Relative Magnitudes of Heat-Transfer Modes

Methods	Magnitudes
Free Convection: Vertical plate, 6-in., $\Delta t = 70 \text{ F}$	1.0
Radiation: Black bodies, $\Delta t = 90 \text{ F}$ Black bodies, $\Delta t = 810 \text{ F}$	1.8 8.1
Forced Convection: Air over 6-in. plate at 8 fps; mest temp plate and air, 212F	an 3.0
Water at 104 F and 5 fps in 2-in. diam pipe	1500.0
Bolling Water: On flat plate at 1 atm	2100.0





vacuum or a gas with practically no absorption. When it is absorbed by other bodies, the receiving-body temperature rises. Thus, in the design of electronic equipment, hightemperature components, which may produce radiation, are not located adjacent to components with critical temperature sensitivities.

Because a large temperature difference between the radiating body and the receiving body is necessary for effective heat transfer by radiation, satellites appear to be a logical application for this type of cooling. A package which utilizes radiative cooling is shown in Fig. 4.

Liquid-cooling techniques transfer heat to a liquid which may or may not be in motion. The liquid is in direct contact with the heat-dissipating component, Liquid cooling includes: Submerged cooling, boiling, expendable cooling, and spray cooling. Various liquid cooling system configurations are also possible.

In Submerged Cooling, the electronic parts are cooled by loss of heat directly to the surrounding liquid. The heat must be given up by the liquid to some ultimate heat sink. Submerged cooling insures uniform temperatures within the equipment and provides an effective method for dissipating a concentrated heat load over a large surface. This method of cooling is applicable to power supplies, servo amplifiers, modulators and similar equipment.

The technique of liquid filling an electronic package increases the weight of the equipment and therefore must be carefully evaluated for

any applications where weight is important. Table 2 indicates relative effectiveness of liquid cooling.

Table 2—Effectiveness of Methods for Internal Cooling of Sealed Units

Cooling Method	Heat Removal (W/cu in.)		
Free air	0.15		
Plastic embedment	0.25		
Metallic conduction	2 to 5		
Forced-air cooling	7		
Direct liquid cooling	10		
Vaporization cooling	20		

Boiling of the liquid increases the heat transfer rate due to agitation of the liquid. This method of cooling is a logical step from submerged cooling, Fig. 5. Fluid properties are of prime importance. The boiling temperature establishes the operating temperature of the equipment, and all components exposed

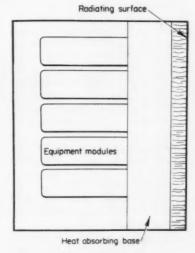


Fig. 4-Radiative cooling unit.

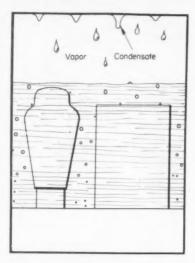


Fig. 5-Vaporization cooling.

to the liquid must be capable of operation at this temperature.

The Evaporative Gravity System of cooling embodies the evaporative-cooling (boiling) technique, Fig. 5. With the proper selection of liquid and pressure, almost any boiling temperature can be obtained and very uniform constant temperatures can be maintained on components sensitive to temperature variation. Freons, and perfluorocarbon fluids have been used as filler liquids.

EXPENDABLE COOLING also involves boiling heat transfer. In this case, the vapor is not condensed, but is permitted to escape, Fig. 6. The latent heat of vaporization is the ultimate heat sink.

Expendable cooling is limited in heat-removal capability by the amount of fluid available. If long periods of equipment operation are expected, this cooling method would probably be prohibitive due to the weight and volume of liquid required. In addition, the electronic package must be structurally capable of withstanding the pressures generated.

SPRAY COOLING is similar to submerged cooling, but requires only about 1/3 as much liquid. In a typical arrangement, Fig. 7, a wick or screen sleeve insures uniform flow of coolant over the heat-dissipating surface.

This cooling method requires that coolant be provided to the heatdissipating parts regardless of package orientation during equipment operation. Thus, for airborne application, this method has limited application. However, for ground installations and shipboard use, this cooling method is applicable.

The various liquid-cooling methods discussed can be applied to cooling systems. In every system, a heat exchanger and a liquid transfer system are required. The primary advantage of a cooling system is that one heat sink is used for a number of electronic packages.

Other methods for cooling electronic equipment are available:

• Equipment can be designed with sufficient mass so that all heat generated during its operation can be stored in the mass without exceeding the temperature limits of the

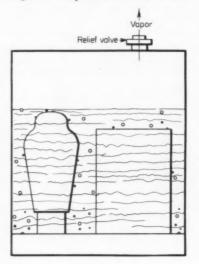


Fig. 6-Expendable cooling.

components.

Since heat transfer from the generating part to the absorbing mass is usually by conduction, thermal paths must be designed for conduction with minimum temperature difference. Air gaps and contact resistances should be eliminated. All metal joints should be welded or soldered with no reduction in the conduction path cross-section area.

A chassis of a telemetry module which employs heat-sink cooling for the vacuum tube is shown in Fig. 8. The first impression of this is that it will weigh too much. But, electronic equipment chassis and cases contain considerable weight for structural reasons. With thermal design considered during initial design stages, the structure which is made to carry mechanical loads will usually absorb thermal loads with little or no increase in weight.

 Another approach to equipment cooling is the application of endothermic and exothermic chemical reactions of the cooling fluids. By suitable selection and control of the reactants and reaction products, good temperature control of equipment appears possible.

• One more cooling method is thermoelectric cooling. Here, an electric current causes heat to be absorbed at one junction and rejected at a second junction. Use of semiconductor materials has made this method of cooling practical for some applications. Technical information sheets indicate temperature differentials of 100 F are obtainable. However, with large tem-

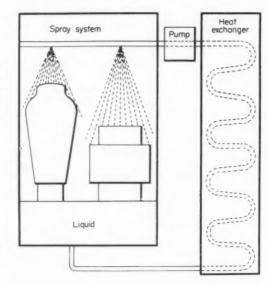
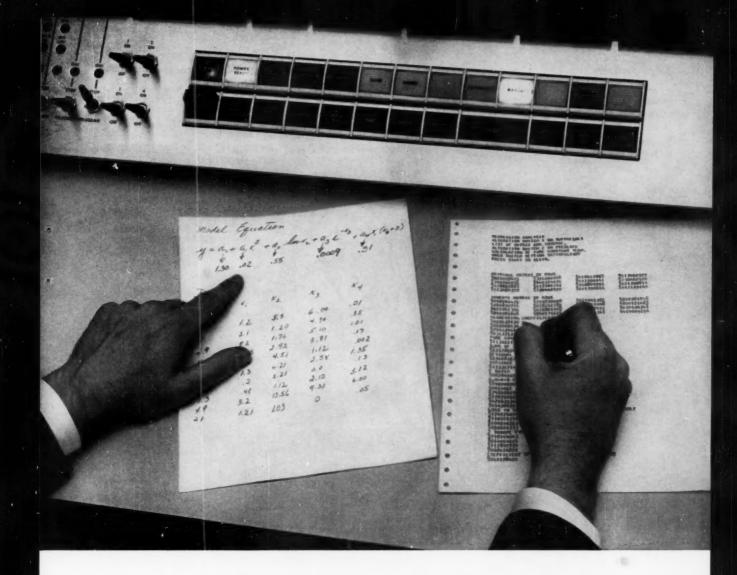


Fig. 7—Spray cooling.



Want to find the coefficients? It's easy with the new Regression Analysis program for the IBM 1620

Here's another program offered free-ofcharge to users of the IBM 1620 Data Processing System. It gives you the kind of results you might expect only from a much more expensive computer. But users of the 1620 know that its low rental cost is deceptive. The 1620 packs more computing power per cubic inch than any other computer in its size range.

The Regression Analysis program is a good example. Suppose you want a fit for production purposes. If you employ more than two variables you probably have difficulty visualizing the representation of your data. If linearity is not the case, you must often guess blindly at a polynomial of high degree, accept or reject the fit with some-

thing approaching a sixth sense, and either try again or settle for the results you have.

The new Regression Analysis program lets you handle expressions containing up to 24 variables. If you have the even more complicated task of handling many dependent variables, the program will generate regression coefficients with a maximum number of dependent variables not exceeding one-half the number of independent variables.

This program will also fit non-linear functions and hyper-surfaces. Compare this performance with that of any other computer in the 1620's price range.

A basic 1620 installation rents for just \$1600 per month. For details, contact your local IBM Representative.



IBM's 1620 is a compact desk-size computer.

IBM DATA PROCESSING

perature differentials, the coefficients of performance (heat load/input power) appear to be low. Careful selection and maintenance of heatsink temperature is important if the Component selection can be guided by factors in good thermal design.

Early in design, the effects of temperature variation on electrical performance should be considered, and temperature-critical and/or temperature-limited components should be identified.

Actual operating temperatures for temperature-limited parts should be established to verify the adequacy of the cooling method selected and derating factors for components such as resistors and rectifiers.

Wire size and insulation class should be compatible with expected equipment operating temperatures.

Consider cooling methods to be applied to various new subminiature and microminiature packaging techniques and solid-state circuits. Although the heat generated by each element is very small, the high packaging density causes severe heatremoval problems. Liquid cooling appears attractive for these applications since high heat-transfer rates are obtainable while maintaining constant component temperatures.

"Trends in Electronic Equipment— Thermal Design and Packaging," presented at the National Meeting of the Institute of Environmental Science, Washington, April, 1961, Proceedings pp. 225 to 234.

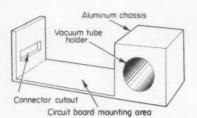


Fig. 8-Typical heat-sink component.

cooling capacity is to be maintained with constant input current. A thermoelectric cooling module, which is commercially available, is shown in Fig. 9.

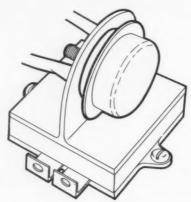


Fig. 9-Thermoelectric cooling module.

Producibility factors in

Gear-Blank Design

I F A PART is relatively easy to manufacture, its cost is low and so is its selling price. This paper is primarily concerned with the application of this viewpoint to design of ferrous spur and helical gears.

Choice of Materials: Ease of manufacture begins with the choice of the material to be used. Here, manufacturers are primarily concerned with machinability. This term is sometimes mistakenly thought to be synonymous with hardness. However, it is determined not only by hardness, but by chemical composition, toughness, microstructure, and the material's tendency to work harden. A wide range of ferrous materials is available to the designer.

For a given machining operation, the usual index of machinability is W. G. WALLACE

Chevrolet-Passenger Transmission Plant General Motors Corp. Toledo, Ohio

the tool life between grinds. The kind of finish produced by the tool and the relative magnitude of the cutting forces on the tool (which is related to power consumption) also become serious considerations. A larger and rigid machine may be necessary if machinability is poor.

Here, the designer must match the gear's physical requirements to the material. The selection of material sometimes has to be modulated by the availability of heattreating equipment, availability of new metal removing methods, and distortion characteristics, with the initial cost of the material becoming a secondary factor.

To maximize production and

minimize cost when making a choice of material, the following variables are involved:

- The gear's physical strength requirements.
- The gear tooth design—compressive and tensile forces, sliding velocities, and stress raisers.
- 3. Machinability of the material.
- 4. Relative ease of heat treatment.
- 5. Machine tool investment.
- 6. Production volume.

To place a value on machinability, an arbitrary standard has been devised which specifies the cutting speed, normal cutting conditions, and other standard reference conditions. Bessemer screw-stock or AISI B1112 cold-rolled steel is rated as 100 per cent under these standard conditions. The speed at which other materials can be machined under optimum conditions is then

Off the shelf

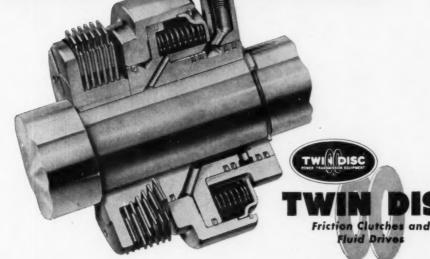


... or off the drawing board



66

CLUTCHES



Designers who want a dependable multiple-plate "wet" clutch usually find what they're looking for at Twin Disc. Clutches built to run in oil have been a Twin Disc specialty since 1923, so Twin Disc application engineers know from experience what a wet clutch will and won't do. They'll be glad to advise you accordingly.

It's more than likely that a standard Twin Disc assembly will satisfy your wet clutch requirements. You can specify hydraulic, electric, air or mechanical actuation, and there's a wide range of standard sizes to meet

the specific torque load of your equipment.

Twin Disc experience is especially valuable where unusual design problems such as high energy loads or rapid cycles are encountered. The most talked-about feature on the new John Deere "1010" Crawler Tractor—an automatic direction reverser—is the result of a special Twin Disc duplex clutch design. Many machine tools of recent design also incorporate special Twin Disc wet clutches for fast, accurate control of table and spindle movements. Assuming rea-

sonable volume, Twin Disc engineers will undertake to design a special clutch for *your* application.

Twin Disc's backlog of research information will minimize your developmental costs. And there's a plentiful inventory of standard clutch plates and other parts on hand to keep your tooling costs low. In fact, Twin Disc has enabled some OEM's to eliminate tooling costs altogether!

Your inquiries will receive the prompt attention of our engineering staff. Write Twin Disc Clutch Company, Racine, Wisconsin.

related to B1112 and expressed as a percentage. These ratings are used extensively for estimating machining costs, selecting material, and processing parts. The designer should use these only as a working guide. Primarily, he confines his interest in the material to its strength and wear characteristics.

The gear blank is produced by one of three methods: 1. Cut from bar stock. 2. Made as a forging. 3. Made as a casting.

Bar-stock blanks can be very attractive from the cost standpoint as they are usually produced on automatic screw machines in volume if the part's configuration and application permits. Turning, boring, drilling, milling, reaming, and hobbing can be accomplished. The use of bar stock minimizes the driving and chucking problem as the part is usually not separated from its parent bar until the last operation.

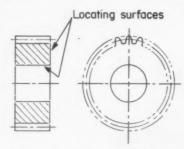


Fig. 1—Ideal gear design has massive section with flat and parallel sides.

If a wide difference exists between several diameters of a great blank, requiring excessive removal of stock, a forging or casting may become more feasible. Forgings can be made as cold extrusions or as products of the forging hammer, press, or upsetter. The choice is dictated by the part and sometimes by the equipment. Blanks can be produced to close limits and with good finishes. Even gear teeth can be formed. In the field of powder metallurgy, gears can be produced in dies from powdered metal to very close limits.

When specifying forgings produced by hammers, presses, or upsetters, the designer should be conversant with the advantages and limitations of each process. The process selected should minimize subsequent machining operations.

Holes produced in the forging by piercing are usually much cheaper than those produced by drilling.

The use of castings in gear blank design should not be overlooked. The physical properties of cast steel and nodular, malleable and other high-strength irons offer a solution for complex parts. Parts can be cast to close limits with excellent surface finishes by the use of shell molds. Surface hardening can be readily accomplished by induction or flame heating.

Selection of Production Machine: To achieve the ultimate in the production of gears—and this applies not only to ease of manufacture, but also to cost, quality and reliability—the part must be a natural product of the machine tool that makes it. The designer's intentions and the machine tool selected must complement each other.

In an effort to keep the unit cost as low as possible, the process engineer attempts to combine operations. He will also do this if critical relationships are to be held to close limits to avoid rechucking or relocating. Special machines may then become necessary, rather than standard tools. The cost of engineering a standard machine is 5 to 10 per cent of its base price. To engineer a special machine tool may cost 40 per cent of the base price. Immediately, the investment in the tooling program greatly increases and flexibility in manufacture is usually sacrificed.

If a choice exists between complexity of design and a multiplicity of parts, each should be carefully processed and estimated to determine the relative advantages or disadvantages. This requires co-operation between design and process engineers.

Complexity in design is related

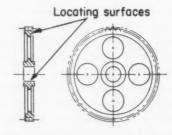


Fig. 2—Aircraft gear lacks rigidity and adequate locating surfaces for ideal processing.

to reliability, which emphasizes the effect on the total end product if many parts are involved. Total end reliability of any assembly depends on continued reliability of each of its components. But, combination of details, to reduce the total number of parts, does not necessarily increase reliability of end products.

From the economic standpoint, the cost of a part increases with the number of operations performed on it. And as the number of operations is increased, the length of time that the part is exposed to human or machine errors is also increased.

Gear Blank Configuration: The matching of gear designs to production processes is a kind of art. One given design may be processed by several competent people, each in a different manner, but a wholly acceptable product will result. The gear blank in Fig. 1 has these basic factors which simplify processing:

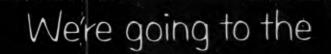
- Massive section will result in less heat-treat and clamping, or fixturing, distortion.
- Flat and parallel sides can be easily produced by parallel wheel grinding. The part can be stacked for multiple hobbing and processing.
- Geometry permits easy locating for centrality and squareness.
- Part can be easily handled mechanically. The transporting, loading, and unloading of automatic equipment is relatively easy.
- Configuration permits various methods of forming the gear teeth; that is, hobbing, shaping, form cutting, and cold forming.

Difficulty in the manufacture of gears is usually in direct ratio to the accuracy desired and the relationship of the design to the methods by which it can be produced.

Common faults which threaten accuracy and producibility of an aircraft gear, Fig. 2, are:

- The blank lacks rigidity which must be supplied by the fixture if accuracy is to be maintained.
- Locating surfaces are inadequate for ideal processing.
- The part may have to be diequenched to avoid excessive distortion.

A common type of gear shown in Fig. 3 would be easier to make if the shaft was divorced from the gear. Its faults are:



NATIONAL METAL SHOW

OCTOBER 23-27

.. because

we'll get ideas by the dozens. We'll get information on how to improve production, cut costs. . . stay ahead of competition.

... I want to study the new advancements in processing, inspection and control equipment. All under one roof at fabulous Cobo Hall.

...it's a real chance to exchange views with leaders in the industry. For five days Detroit will be the Engineering Capital of the world. trials Applications Center will be one of the great "eye-popping", thought-stimulating exhibits of the year.

everyone will broaden and up-date their knowledge of the metalworking industry ... more than 300 educational exhibits and more than 200 technical papers to SEE and HEAR.

Don't "miss the boat". Make your registration today. Organize a company group. For further information contact the ADVANCE REGISTRATION MANAGER, ASM Headquarters, Metals Park, Ohio.

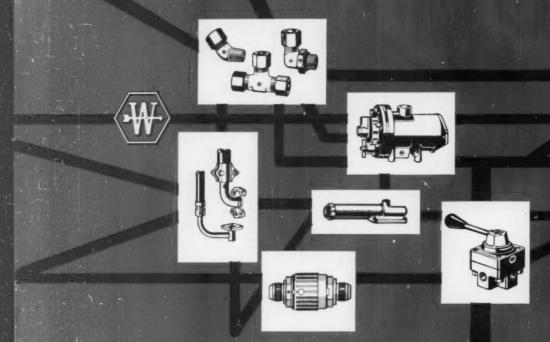
HOW ABOUT



NATIONAL METAL SHOW · DETROIT · COBO HALL · OCT. 23-27
SPONSORED BY AMERICAN SOCIETY FOR METALS · METALS PARK, O.

10450-ASM

WEATHERHEAD FLUID POWER PRODUCTS... SYSTEM ENGINEERED



WEATHERHEAD ERMETO "THE ONLY FITTING WE'VE FOUND THAT ELIMINATES TROUBLE"

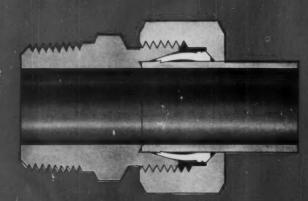
This is typical of reports from users of these self-sealing, high-pressure flareless connectors. Reasons: ease of assembly and disassembly; no special tooling required; avoids threading and flaring while providing positive seal; reusable—maintaining notical, stress-free support of tubing after multiple make and breaks.

Weatherhead Ermeto fittings are engineered to withstand severe vibration, shock, pulsating loads, temperature extremes, and pressures to 15,000 psi.

For your fluid system reliability, specify Veatherhead Ermeto.

A complete range from 1/6" to 2" is available from your nearby Weatherhead distributor.

THE WEATHERHEAD COMPANY



ERMETO

Circle 297 on Page 19

WEATHERHEAD HYDRAULIC POWER Components

VARIABLE DISPLACEMENT PUMPS





Meet J.I.C., S.A.E., and M.S. standards. Pressures to 3000 psi



Pressure Control, Automatic (Constant) Flow Control, Manual Displacement Control









Fixed Displacement Hydraulic Motors, Reversible Variable Displacement Hydraulic Motors (Integrated Torque and



HIGH PRESSURE HOSE AND FITTINGS

Swaged, Crimped, and Field-Attachable Flexible Hose Ends.











THE WEATHERHEAD CO.

300 EAST 131 ST. • CLEVELAND 8, OHIO Distributors in all major markets

DESIGN ABSTRACTS

- The forging becomes quite complex if stock to be removed is to be held to a minimum.
- The part cannot be hobbed or shaved from centers alone due to lack of rigidity. Fixturing must be provided adjacent to the gear teeth if accuracy is to be maintained.

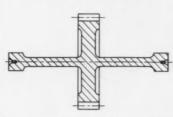


Fig. 3—Forged gear design would be easier to process if gear and shaft were separated.

The gear in Fig. 4 represents the problem of reference features. Should locations be specified from the bore for both squareness and centrality? Or, should locations be specified from the meager face for squareness and the bore for centrality? Some of this gear's faults are:

- Very little surface to locate from for squareness.
- The thin section under the teeth contributes to machining and heattreating distortion.

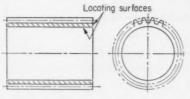
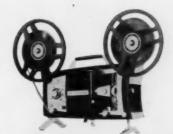


Fig. 4—Thin-walled gear blank would be difficult to process because of inadequate reference features.

The gear in Fig. 5 represents a degree of complexity which is quite common. However, in volume production, it has these faults:

- The undercut under the teeth will contribute to lead heat-treat distortion.
- Concentricity of the pitch diameter to both conical surfaces is difficult to maintain.
- Minimum shaper-cutter clearance gap under the gear teeth causes short cutter life and set-up problems.
- Configuration will probably make necessary a switch in locating surfaces during machining, thereby leading to poor dimensional control.



KEYSTONE

is keen on high starting torque, variable speed of

HEINZE

SMF MOTORS

Motors for Keystone Projectors must have reliable high starting torque and variable speeds. Heinze SMF Universal Motors meet these needs precisely. Motors are available in hp ratings from 1/10 to 1/30; load speeds of 5,000 to 7500 rpm; 115 V AC/DC or other voltages in AC or DC. This is just one of a comprehensive line of compact Heinze Universal Motors. They feature high starting and running torque, are versatile to allow all types of mounting arrangements and modifications, are uniform in quality, keyed to high production, and competitively priced.

Write for complete catalog.



ELECTRIC COMPANY 685 Lawrence St. Lowell, Mass.

SUB-FRACTIONAL HORSEPOWER

Circle 298 on Page 19



Fastening the V-shaped braces to these table legs was giving the manufacturer trouble. Sheet metal screws loosened under daily use, gave an unfair impression of the product.

Now Detroit Breakfast Furniture Company, Detroit, Michigan, installs Rivnuts into the legs, fastens the braces with screws inserted in the Rivnuts. The fastening is shakeproof, strong, and contributes to a clean design and appearance.

RIVNUTS are the original one-piece blind rivets with internal threads. To see if they can help on your fastening problems please send a print of your part. For bulletin, see Sweet's Product Design File, or write Dept. MD-9, B.F. Goodrich Aerospace and Defense Products, a division of The B.F. Goodrich Company, Akron, Ohio. In Canada: Kitchener, Ontario.





Fig. 5—Complex section has faults that would lead to poor dimensional control in volume production.

Dimensional Control: In the area of dimensional control, it is important that the gear designer and the process engineer agree on dimensional base lines. Limit stack-of complex assemblies, in order to determine resultant clearances and fits, is common design practice. It is equally important for the process engineer to carefully analyze his process by dimensional control studies to be sure that the part as produced will meet the part drawing requirements.

Heat Treatment: After the gear has been produced, it has to be hardened. Design of parts for ease of heat treatment is not easy. To avoid the use of complicated quench fixtures, designers should avoid complex sections. Previous designs of various shapes of gears can be studied to determine their behavior during the development of quenching methods.

The purpose of hardening gear teeth is twofold—a hard wear-resistant surface is desired and maximum strength is essential. Basically, this is accomplished by the use of so-called through-hardening or case-hardening methods. The choice is dependent on the application, equipment availability, and cost.

Generally, steel containing less than 0.25 per cent carbon is considered carburizing steel. Throughhardened steels are hardened by heating them above their critical enough rate to form martensite. Carburizing grades of steel have carbon added to the surface, and are quenched directly from above their critical limit, or are allowed to cool slowly and then are reheated and quenched. From the ease-of-manufacture viewpoint, the problem of heat treatment varies with the amount of equipment or preliminary procedures when the

superior latching P&B relay



LIES FLAT FOR GREATER PACKAGE DENSITY, HIGHER PERFORMANCE



This DPDT, permanent magnet, latching relay is superior on these counts: (1) shorter height for maximum compactness between stacked circuit boards; (2) greater sensitivity (80 milliwatts); (3) better vibration resistance (30 g to 2000 cps); (4) better

watts); (3) better vibration resistance (30 g to 2000 cps); (4) better shock resistance (100 g).

Designated the FL Series, this relay meets all applicable sections of MIL-R-5757D, MIL-R-6106C and ABMA #PD-R-187.

Call your nearest P&B representative today for complete information about the whole P&B family of microminiature relays.

FL SERIES SPECIFICATIONS

Contact Arrangement: DPDT

Shock: 100 g for 11 milliseconds with no contact openings.

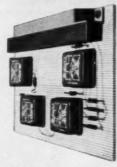
Vibration: .195; max. excursions, 10 to 55 cps. 30 g from 55 to 2000 cps. No contact

Linear Acceleration: 400 g minimum with no contact openings.

Pull-in: 150 milliwatts, approx. (standard) at 25°C. coil temperature.

80 milliwatts, approx. (sensitive) at 25°C. coil temperature

Operate Time: 3 milliseconds max. at nominal voltage at 25°C. coll temperature Dimensions: .485" high, 1.100' long, .925"



Printed circuit board using 4 FL relays was designed by the Martin Company, Orlando, as part of ground support equipment for a major missile project.

THERE'S A P&B

CRYSTAL CASE RELAY FOR YOUR PROJECT

Diode in relay case is used for arc suppression in special applications. Four diodes form full-wave bridge rectifier for 400 cycles.





Non-latching or latching relays in conventional crystal cases with or without shoulder brackets, studs or mounting plates. All types of ter-minals are available.



Terminals spaced on .200" grids are available on all P&B microminiature relays. These carry a "G" suffix (SCG and SLG) and are .890" high, .800" wide, .400" deep, max.

These 3 relays are shown slightly reduced in size.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONICS PARTS DISTRIBUTOR



DIVISION OF AMERICAN MACHINE & FOUNDRY IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO



single and double clutches or brakes

DESIGN PRINCIPLES OF THE 3 BASIC TYPES

The Maxitorq Clutch is completely assembled on the clutch body and shipped ready to slip onto a shaft. Separator springs... an outstanding feature... assure the advantages of truly floating discs. Used between each pair of inner discs, they spread them endways with an accordian action so that light can be seen between all discs when the clutch is in neutral. The floating disc feature makes certain that there's no drag... no abrasion... and consequently no heat when the clutch is in neutral.

A locking plate on the disc end of each clutch (two on the double types) locks all discs against tension developed by the separator springs. Manual adjustment is made by raising the lock spring, then turning the adjusting ring to give the desired shifting pressure.

Note that assembly adjustment and take-apart are all manual...no tools required.

Standard Maxitorq Clutches are available in single and double types, wet or dry...also in pulley and cut-off coupling types. Capacities to 15 h.p. at 100 r.p.m.Write Dept. MD for bulletin today.



part is quenched. When this precise article, a gear, is abruptly quenched through hundreds of degrees, two things happen:

- Severe thermal changes are created which may cause cracking due to unequal contraction of elements of the gear.
- Stresses are set up because the transformation to martensite is causing the steel to expand at the same time that quenching is causing it to cool and contract.

The gear should be designed to have equal sections to avoid unequal cooling stresses.

Through-hardening grades of steel are sometimes preferred because the process of adding carbon to the surface of the gear is avoided. Carburizing grades of steel for gear manufacture have an advantage also. The addition of a heavy case depth to the gear tooth surfaces produces favorable residual stresses if properly handled. The surfaces of the gear teeth are heavily prestressed in compression which is favorable in increasing fatigue life.

Carbo-nitriding, or the process of adding nitrogen and carbon in the austenite stage of hardening, is used extensively to keep gear distortion to a minimum. Carbo-nitriding can be carried out at a lower temperature than carburizing and slower cooling rates can be used in hardening, thus resulting in decreased distortion.

Flame or induction heating of gear tooth surfaces can result in a minimum of distortion and offers a practical solution to some knotty heat treat problems.

SAE Paper No. 333B, "The Gear Blank and Heat Treatment," presented at the 1961 SAE Automobile Week, Detroit, March 1961, 7 pp.

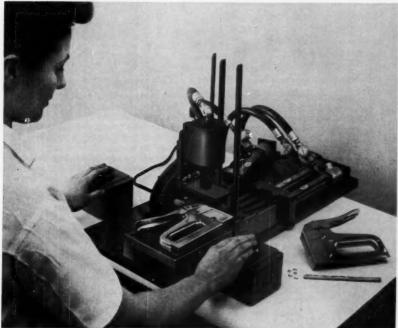
electrical

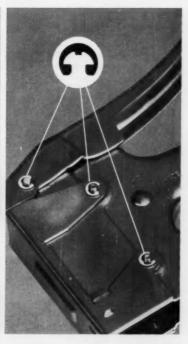
Digital Speed Regulator

J. Dobbic, Westinghouse Electric Corp., Buffalo, N. Y., and E. C. Fox Jr., Westinghouse Electric Corp., East Pittsburgh, Pa.

A digital speed regulating system which is capable of providing accuracies and flexibility beyond

Here's how ARROW FASTENER Co. gets Truarc Retaining Rings FREE!





U.S. PAT. NO. 2.837.815

Mechanized Ring-O-Mat® designed by Truarc Engineers doubles stapler production for saving of \$2500/year

Arrow Fastener Co., Inc., Brooklyn, N. Y., uses three Truarc Series 5144 reinforced E-rings to secure components in its Model T-50 compression stapler. Originally, Arrow operators installed the rings by hand with conventional applicators and dispensers. Fast? Sure—but Truarc engineers suggested to the company how the job could be done even faster and more economically by mechanizing the entire ring assembly operation.

Working closely with the Arrow engineering and production staff, Truarc mechanization engineers designed the unique Ring-O-Mat shown above. The unit installs the three E-rings in a single operation, twice as fast as the former hand method. Savings with the equipment are \$2500 a year — enough to pay for all the rings the company uses!

Here's how the Ring-O-Mat works. The Truarc rings are supplied in tape-wrapped Rol-Pak® cartridges which are loaded on vertical magazine rails at the center of the unit. To install the rings, the operator merely places the stapler in a nest at the front and pushes the control buttons . . . the Ring-O-Mat does the rest! Applicators connected to the air cylinders grasp the bottom ring in each stack and move forward, seating the rings in accurately located grooves pre-cut in pivot pins extending through the body of the stapler. When the rings are fully seated, the applicators are withdrawn automatically and the operation is completed. Simple, fast, fool-proof - a typical example of how Truarc retaining rings lend themselves to mechanized assembly. A good example also of how you get more than a fastener when you buy Truarc!

Interested in getting your retaining rings FREE?

Bulletin 459-13 describes a number of assembly techniques for mass-production ring installation. Write for a copy or see your Truarc representative.

WALDES KOHINOOR, INC.

47-16 Austel Place, Long Island City 1, New York

61-5



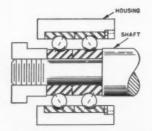
ideas you can use in working with bearings



Miniature and instrument bearings must be protected in the user's plant so that the precision built into them will be fully realized in an assembled instrument. One form of protection is the use of rubber finger cotts by everyone handling bearings to prevent the corrosion of polished surfaces from skin acids—a serious threat to optimum bearing performance.



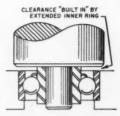
150-page Design and Purchasing Manual is the most comprehensive treatise on miniature and instrument ball bearings ever published. Write for your copp — on your company letterhead, please



The problem of confining radial and axial shaft displacement to an absolute minimum in instruments such as gyroscopes can be solved readily by the use of duplex bearings. These "matched pairs", constructed to eliminate axial play, do away with painstaking and time-consuming use of shims mounted against one face of single bearings. Duplex pairs are matched by NHBB to customer specifications.



Radial play — the displacement of one ring with respect to the other along the diameter of a bearing — is important in the successful application of precision bearings and should be specified on orders. A range of .0002" to .0005" is satisfactory for most applications. The minimum clearance should be .0001" and the total spread from min. to max. should be at least .0002".



When small bearings are mounted against surfaces such as flat gear faces there must be sufficient clearance to allow the outer ring to revolve independently, especially when there are thrust loads and axial play. NHBB extended inner ring bearings (the inner ring is .0312" wider than the outer) provide ample clearance. They eliminate the need for — and provide a firmer, more precise bearing seat than — washers, sleeves or gear hubs.



Machined type retainers of laminated plastic permit higher speeds than stamped metal retainers and, because of the porosity, act as lubricant reservoirs. Bearings with machined retainers can withstand thrust load in one direction only because either an inner or an outer land must be ground off to permit assembly. Since most applications involve a pair of bearings which can be mounted to oppose one another this limitation is seldom a disadvantage.

ITPI	TYPICAL SPECIFICATIONS OF NHBB EXTENDED INNER RING BEARINGS					
BORE	OUTSIDE DIAMETER	WIDTH	WIDTH	BEARING NUMBERS	RADIUS	C
.0469	.1562	.0937	.0625	SROEE	.005	19
.0550	.1875	.1094	.0781	SRIEE		28
.0781	.2500	.1250	.0937	SRI-4EE	.006	39
.0937	.1875	.0937	.0625	SR133EE	.005	21
.093 <i>7</i> .1250	.3125 .2500	.1406 .1250	.1094	SR1-5EE SR144EE	.006	64 36
.1250 .1250	.3125 .3750	.1406	.1094	SR2-5EE SR2-6EE	.006 .006	66 66
.1562	.3125	.1406	.1094	SR155EE	.005	35
.1875	.3125	.1406		SR156EE	.005	35
.1875	.3750	.1562	.1250	SR166EE	.008	82
.2500	.3750	.1562	.1250	SR168EE	.008	44
.2500	,5000	.1562	.1250	SR188EE	.010	120
.3125	,5000	.1875	.1562	SR1810EE		60

ALSO AVAILABLE IN FLANGED AND SHIELDED CONSTRUCTION.

HAMPSHIRE

BALL BEARINGS, INC.

PETERBOROUGH, N. H.

new instrument bearings let you beef up the shaft without increasing bearing O.D.



Here are four new opportunities to design shaft-to-housing relationships not possible with other bearings. Thinner cross sections permit extra large bore-to-O.D. ratios.

This new series is manufactured to ABEC-5 precision standards or better, of 440C stainless steel, with plastic crown retainers which act as lubricant reservoirs.

80RE + .0000	DIAMETER + .0000	WIDTH	BEARING		BA	LLS	,
0002	0002		NUMBER	RADIUS	NO.	SIZE	RATING
.3750	.6250	.1562	SR420T	.010	12	1/16	81
.5000	.7500	.1562	SR8247	.010	16	1/16	95
.6250	.8750	.1562	SR1028T	.010	18	1/16	98
.7500	1.0000	.1562	SR1232T	.010	22	1/16	108

NEW HAMPSHIRE BALL BEARINGS, INC. PETERBOROUGH, N. H. that obtainable by present day analog speed regulators.

The speed regulator consists of digital reference, feedback, and speed and position error circuits.

In all regulating systems, one major problem is speed drift. Speed drift is an undesired change of speed when no apparent disturbance occurs. The cause of drift is the change of characteristics of a critical component such as the change of resistance value with temperature. Drift is most critical in the reference, feedback, and comparison circuits where changes are not compensated for by the system openloop gain.

By the use of digital signals in the reference and feedback circuits and in the error detection circuits, the problem of drift can be virtually eliminated. Until recently, the use of digital circuits for speed regulators was impractical because of the number of components required and the doubtful reliability of the system with components then available. With the development of the transistor and semiconductor diodes, the use of digital circuits has become practical.

AIEE Paper No. CP 61-714, "A Digital Speed Regulating System," presented at the AIEE-AIChE-ASME-IRE-ISA Joint Automatic Control Conference, Boulder, Colo., June, 1961, 8 pp.

Building Block Technique For Digital Systems

J. V. Werme, manager, Electrical Engineering Dept., M. Maczuzak, application engineer, and C. H. Terrey, application engineer, Bailey Meter Co., Wickliffe, Ohio.

A building - block approach to obtain wide variety in design of digital systems.

A middle-of-the-road approach to the size of the building block and the complexity of the circuitry has been chosen in an effort to reach an optimum in flexibility and reduction of engineering and check-out time. Circuit combinations which are found to be used in many different systems are assembled into one module and thus replace a certain amount of engineering effort.

For industrial applications, physical design must be rugged. It must be easy to service and must be reasonably compact. The type of ap-



Complete range of types—closed-center, tandem, two-position configurations, etc.

3000 p.s.i. pressure—rated pressure may be applied to all ports.

Operate solenoids without flow or pressure.

Light and compact—weighs only 5 pounds complete.

All moving parts operating in oil.

The photograph shows three Waterman Series 1617 D.C. 4-Way Solenoid Valves banked for convenient installation. Standard kits, including mounting feet, are available for banking up to seven valves; more on special order. Installation of multiple valves is greatly simplified. It is easy to add more functions later.

Send today for new Catalog 2003







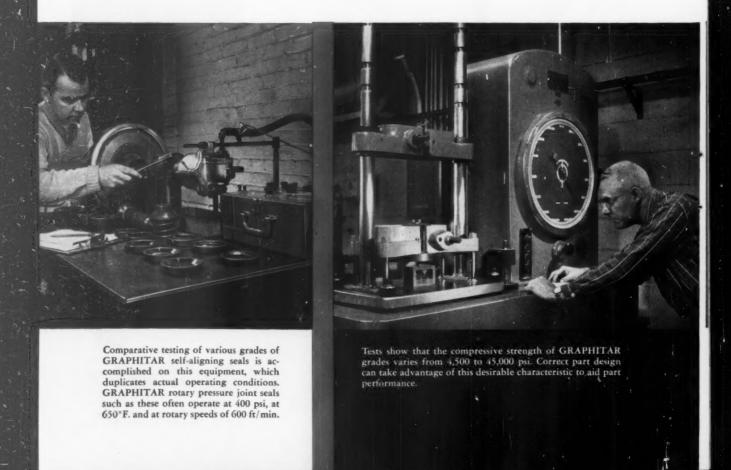
GRAPHITAR

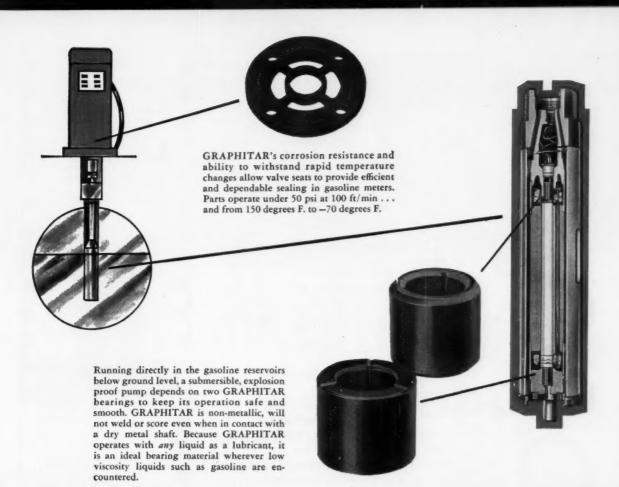
ICARBON GRAPHITE

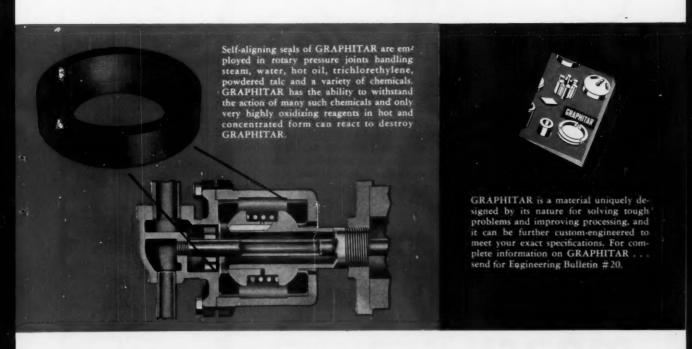
FOR PERFORMANCE

Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters.

These valves incorporate GRAPHITAR seats. Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.







THE UNITED STATES GRAPHITE COMPANY



DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



group for extreme services requiring the ultimate in accuracy and stamina.

SERIES also for tough services, but less se-



SERIES

vere than the conditions served by the 'Mastergauge'

for the general run of gauge services. Marsh quality and accuracy at a mod-

Within these three comprehensive Marsh groups you have the world's widest (yes, and wisest) selection of pressure gauges. These groups of gauges are not grades ...they are kinds...the MARSH kind... which means that each gauge, within the scope of its rated use, is the BEST of its kind!

Pick the right Marsh Gauge and you have the best answer to your gauge problem.

Ask for latest data

MARSH INSTRUMENT COMPANY

Division of Colorado Oil and Gas Carporation *
Dept. B, Skokie, III., Marsh Instrument & Valve Co.
(Canada) Ltd., 8407 1037d St., Edmonton, Al-berta * Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas * Eastern Seoboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N.J.

VAIVES

Circle 306 on Page 19

DESIGN ABSTRACTS

plication requires a long useful life which may, in some cases, exceed 30 years.

For industrial use, it is essential that extremely conservative circuit design be used. A relatively large swing between the "on" condition and the "off" condition is necessary to make the system as immune to noise pickup as possible. Finally, the packaging density must be such that the system is almost completely unaffected by rather violent ambient conditions sometimes met in industrial environments.

ISA Preprint No. 8-TC-61, "The Building Block Approach To Digital Systems," presented at the Summer Instrument-Automation Conference and Exhibit, Toronto, Ontario, Canada, June 5-8, 1961,

techniques

Procedure for Simplified Shaft Design

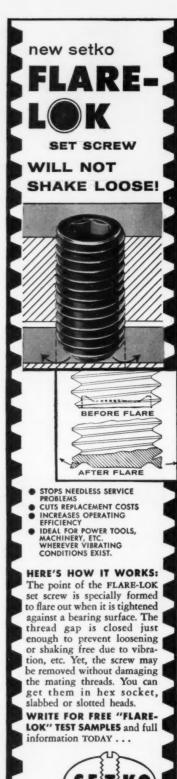
P. E. Burke, Roy C. Ingersoll Research Center, Borg-Warner Corp.

Design procedures for shafts with or without stress concentration fac-

To date, most shafts have been designed to one stress, which usually results in excess service life. In the automatic transmission field, particularly, new designs are required to transmit more power within the same or even smaller housings. To meet these requirements, the engineer must either do excessive preliminary testing on prototypes (which is usually not done), or have background data on various shafts in the form of S/N curves and service conditions.

This paper describes an attempt to simplify the procedure for shaft design. This treatment has been primarily for steel shafts loaded in pure torsion, but similar methods can be applied for bending or combined bending and torsion.

It is not the intent of this paper to propose designing shafts to the critical limit, unless necessary, but merely to give the designer a clearer impression of the problem he is facing. Using the method outlined in this paper will help the designer evaluate such items as hardness and stress concentration factors somewhat better and will tend to min-



28 Main Street, Bartlett, Illinois



Shell Tellus Oils are refined and formulated to meet exacting hydraulic service requirements, such as in this forming machine.

PHOTO COURTESY ATLANTIC PLASTICS INC., STAMFORD, CONNECTICUT

BULLETIN:

Shell provides a quick 6-point check list for hydraulic oils: Use it to pick the right oil for your needs

Selecting the proper hydraulic fluid for your equipment can be one of your most important decisions. And it can pay off in many ways. Less down time. Lower cost per unit. Longer equipment life.

Here are six bench marks to help you pick the best hydraulic oil for your plant requirements.

- 1. Does it have good oxidation stability? Oxidized hydraulic oil can form gums, lacquers and other deposits which may foul moving parts. Shell Tellus Oils are carefully refined to remove unstable, sludge-forming components, then fortified with a Shell-developed oxidation inhibitor.
- 2. Will it resist foaming and emulsification? Pump chatter and erratic operation are often the result of pump cavitation, brought on by oil foaming. Tellus[®] Oils contain powerful additives to help prevent foaming.

They also contain a selected inhibitor to combat effects of moisture that might be in the system.

3. Does it fight rust and corrosion? It is difficult to exclude all moisture

from a hydraulic system. And moisture can form troublesome rust. Shell Tellus Oils have been carefully compounded to resist corrosion.

- **4.** What are its lubrication qualities in continuous service? Shell Tellus Oils form a clinging, oily film on mating metal surfaces. This maintains a constant guard against wear.
- **5.** How does it react to temperature changes? This is a key factor in the performance of hydraulic equipment. Careful selection of the proper viscosity grade of Tellus assures satisfactory operation of your system over its entire temperature range.
- **6. Is it available in several viscosity grades?** Shell Tellus Oils are available in a broad range of viscosity grades.

There's a special grade for virtually every hydraulic requirement.

Ask your Shell Industrial Products Representative for facts on Tellus Oils. Or write: Shell Oil Co., 50 West 50th St., New York 20, N. Y.

A message to manufacturers of hydraulic equipment

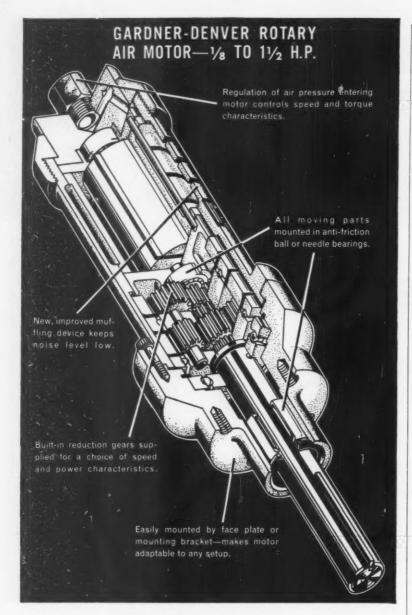
There is a Shell Tellus Oil suited for your equipment.

- 1. Your customers can get Tellus Oils at Shell depots everywhere. Readily available throughout the world.
- **2.** Quality is consistently high. Tellus always delivers top performance.



A BULLETIN FROM SHELL

-where 1,997 scientists are working to
provide better products for industry



Want new design ideas? Check air power

Gardner-Denver air motors offer control flexibility, vibrationless operation, high torque at any speed, freedom from overload damage and spark-free operation. And remember, Gardner-Denver products are backed by factory-trained specialists in our plants and offices throughout the world. Parts and specialized service are always available. For details, call your Gardner-Denver air power specialist, or write for air motor bulletins.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW



Gardner-Denver Company, Quincy, Illinois In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario imize failures in the first prototype designs.

SAE Paper No. 359D, "Shaft Design for Finite Life," presented at the SAE Summer Meeting, St. Louis, June, 1961, 4 pp.

Use of An Efficiency Factor To Find Mass Moment of Inertia

Gene T. Carpenter, aeronautical research engineer, and Dan T. Meredith, engineering technician, Structures and Mechanics Div., Marshall Space Flight Center, NASA, Huntsville, Al.

Derivation, by experimental means, of empirical correction to classical procedures presently used to measure mass moments of inertia by a torsion-rod system.

The use of an efficiency factor E is incorporated in the mathematical equation $I = Kt^2$ to be $I = EKt^2$.

The relationship between a perfect measuring system (a nonexisting absolutely frictionless fixture with no internal or external drag forces, capable of producing "perpetual motion") and a normal measuring system operating in an average environment is used to determine the efficiency factor.

Through intense investigation, it is proved that the decay or damping experienced with a normal measuring system is directly related to some combination of the system configuration and mass of that object contained within it. This relationship is established and applied to resulting inertia measuring methods.

SAWE Technical Paper No. 296, "The Derivation of an Efficiency Factor and Its Application to a Torsional System for Determining Mass Moments of Inertia," presented at the 20th National Conference, SAWE, Akron, Ohio, May, 1961, 23 pp.

Flame-Sprayed Sensing Devices

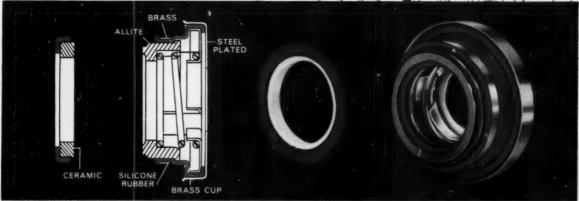
Stan W. Leszynski, research specialist, Boeing Co., Seattle, Wash.

Adaptation of the flame spraying technique to the attachment and fabrication of various types of high-temperature sensing devices.

By this method, a strain sensor, for example, can be "sprayed" onto the test structure using refractory ceramics and alloys.

Extensive work with the flame spraying method has led to the development of reliable strain and Happy wash days depend on round the clock sealing action

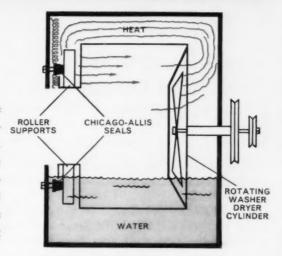




CHICAGO-ALLIS SEAL DESIGN RESISTS HEAT, WATER, SOAP, DETERGENTS AND DIRT... SEALS GREASE IN ROLLER BEARINGS FOREVER

When assigned the engineering task of designing a lifetime seal for a nationally known washer-dryer machine product, Chicago-Allis came up with the right answer pronto. The C-A seal protects bearings in rubber rollers which support the rotary washer-dryer cylinder. Rubber component parts in the C-A seal are molded of silicone and resist heat up to 240° F. Spring loading of the surface sealing elements (Allite and Ceramic), creates a life-long water and grease tight seal.

A typical example of how Chicago-Allis meets specialized needs in mechanical seals and custom molded rubber parts.



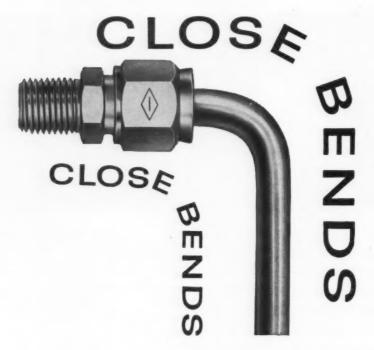
Four mechanical seals are used in this washer-dryer application—two of which must operate *under water* during the washing cycle, and all are exposed to extreme heat during the drying cycle.

Send for complete information on all Chicago-Allis products and services.

"Chicago-Allis Engineers to your Specifications"



no problems with...



With Hi-Seal* fittings you can make tube bends close to the fitting—in fact, right next to it. Here Hi-Seal is in a class by itself.

Hi-Seal's simplified design with flareless butt joint makes this possible. The advantages? More compact layouts. Save on tubing. Shorten installation time by as much as 50%. Gain utmost reliability. SAVE MONEY. To get these advantages, insist on Hi-Seal.

For complete information, write for Bulletin 3108.

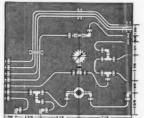


HI-SEAL

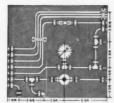


In Canada: Imperial-Eastman Corporation (Canada) Ltd., Torento

Look at what you can do when you use Hi-Seal fittings:



This typical layout has "old-fashioned" tube fittings. Layout area, 257 sq. in.; 12.7 ft. of tubing; installation time 2 hr., 34 min.



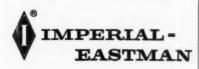
Same layout with Hi-Seal tube fittings. Layout area reduced 32% to 175 sq. in.; tubing reduced 40% to 7.7 ft.; installation time reduced nearly 50% to 1 hr., 20 min.!

All this is possible because of Hi-Seal's exclusive flareless, butt joint design. This means that tube bends may be made right next to the fittings. Even direct tube connections may be made without any extra loops to allow for tube entry into the fitting.

One Fitting for the Entire System However varied your requirements may be, Hi-Seal meets them. Available in all styles, sizes and combinations, plus a variety of metals: steel, stainless steel, brass, aluminum, titanium, Monel, etc.

Now Imperial-Eastman meets all your requirements for hydraulic-pneumatic-flow system components: tube fittings, valves, couplings, flexible and rigid hydraulic and pneumatic hose, thermoplastic tubing, tubing tools.

FITTINGS



thermo sensors under controlled and refined application conditions. Test results indicate strain sensor accuracies of 3 per cent up to 1000 F. At higher temperature levels up to 2000 F, flame sprayed strain sensors have demonstrated remarkable temperature s t a bility—a condition which results from the sensing material being exposed to extremely high temperatures during fabrication.

ISA Preprint No. 22-TC-61, "The Development of Flame Sprayed Sensors," presented at the Summer Instrument-Automation Conference and Exhibit, Toronto, Ontario, Canada, June, 1961, 9 pp.

Experimental Psychology Applied in Design

A. Kahn, Air Arm Div., Westinghouse Corp., Baltimore, Md.

Contributions of the experimental psychologist to the problems that develop in the design of human-operated equipment.

Experimental work in this field is classified and reported in four major categories:

- The relationship between the characteristics of the human eye and radar display design.
- The relationship between the human's perceptive capability and the reconnaissance system design.
- The human as a processor of information.
- 4. The human's characteristics as an integral part of a tracking system.

"Experimental Psychology — A New Variable in Design," Westinghouse Engineer, Vol. 21, No. 4, July, 1961, pp. 112 to 116.

mechanical

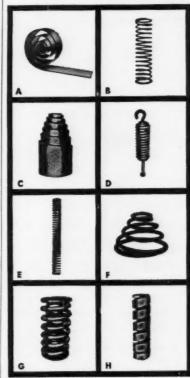
Whirling of Unsymmetrical Rotors

P. J. Brosens, assistant professor of mechanical engineering, and S. H. Crandall, professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

A study of the motion of overhung rotors rotating at constant speed, having unequal diametral moments of inertia, and supported pivotally with unequal stiffnesses about mutually perpendicular stationary axes.

Gyroscopic coupling is included throughout.

Can you identify these springs?



A. flat B. helical C. volute D. extension
E. helical F. cone G. helical, triple-coil
H. rectangular section

Over One Million ALCO SPRING DESIGNS

ALCO's complete line of "performancerated" springs ranges from small springs for light work to heavy-duty triple-coil springs for heavy, sustained work

In over 80 years, Alco engineers have produced more than one million spring designs to serve almost every conceivable application.

For your next spring job, contact your nearest ALCO sales office. To obtain brochure, ALCO Springs for Industry, write to ALCO Products, Inc., Dept. 160, Schenectady, N. Y.

ALCO

ALCO PRODUCTS, INC.

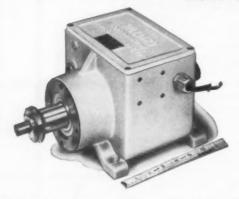
NEW YORK

SALES OFFICES IN PRINCIPAL CITIES

Circle 312 on Page 19

HILLIARD'S

New"I.D.U."



A complete, packaged unit that gives you precise control of intermittent motion from a constant rotary power source!

Built-in features:

- Contains all the parts in one package.
- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- nstant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

Can be installed on existing equipment, designed into new machinery and re-used after production line changes.

A single package unit that gives you precise control of intermittent motions . . . oscillate or repeat . . . clip and bend . . . shear or slash . . . raise or lower . . . index and position . . . from a constantly rotating source of power.

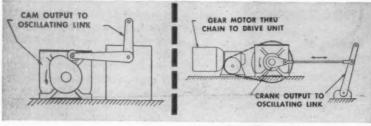
of power.
HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a "custom" machine with assorted mechanisms to control it.

to control it.

"I.D.U." features highly flexible control—manual, mechanical or electrical—permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "washdown" conditions.

Write on your letterhead stating your intermittent motion problems and we will provide complete information.

Typical intermittent controls by "I.D.U"



Basic Unit Price \$289.00

Optional accessories extra

The HILLIARD Corporation

103 W. FOURTH ST.

ELMIRA, NEW YORK

CANADA OPTON-BRADHEN-JAMES LTD.

DESIGN ABSTRACTS

It is found that some rotors are dynamically unstable above a certain speed and that some of these may return to a stable condition at a sufficiently high speed depending on the particular magnitudes of the gyroscopic coupling and the inertia inequality. The effect on rotor stability due to nonrotating inequality in the supporting stiffnesses is For small stiffness instudied. equality this effect is only of second order; as the stiffness inequality is increased, new unstable speed regions may appear. Test results on an unsymmetrical rotor verify the theoretical predictions.

ASME Paper No. 61-APM-10, "Whirling of Unsymmetrical Rotors," presented at the Summer Conference of the Applied Mechanics Div., Chicago, June, 1961, 8 pp.

Light-Weight Threaded Fasteners

James B. Duke, Elastic Stop Nut Corp.

Status of currently available lightweight threaded fasteners, reviewed with emphasis on miniaturization, structural weight reduction, installation ease, and high-temperature adaptability.

Stress is placed on the need for critical review of fastener selection procedures, particularly when different elements of an aerospace system are involved. Among the most profitable areas for weight-control study are those in which use of existing lightweight parts can be extended to new environments, or new strength levels, providing gross weight reduction by parts which are closely tailored to actual needs.

Fastener reliability and assured quality are considered to be of utmost importance. The development of a new threaded fastener system, aimed at providing a very high level of fatigue life and endurance, is presented.

Several new types of "installation utility" or cost-reduction fasteners are described with application notes.

The growing emphasis on avionic components for aerospace systems requires a re-orientation of traditional aircraft assembly methods. The highly developed fasteners for such electronic units are outlined, with their cost and weight reduc-



Rigid tolerances are specified, and extra machining operations are performed to increase the area of contact. Nevertheless, it has been impossible to mate two metal surfaces perfectly, one inside the other. The Perfect Fit, like Infinity and Perpetual Motion, has seemed to exist only in theory.

YET A FEW DROPS OF LOCTITE CAN NOW PROVIDE WHAT THE MOST EXPENSIVE OF MACHINING METHODS CANNOT.

LOCTITE Sealant is a penetrating liquid resin that by capillary action is drawn into all the voids in a press or interference fit, filling them completely. Once there, LOCTITE hardens automatically into a tough, solid, load-bearing plastic film, capable of supporting loads in excess of 25,000 pounds per square inch, thus providing A PERFECT FIT of adjacent surfaces.

- FACTS ABOUT LOCTITE SEALANT:
- LOCTITE is easy to use. It requires no mixing or heating.
- LOCTITE is 100% active. It totally fills the voids in press fits and threaded assemblies.

- LOCTITE contains no solvents-requires no solvents. There is no hardening shrinkage due to solvent evaporation.
- LOCTITE requires no expensive equipment. The bottle is the applicator; or mass application procedures can easily be set up with "around-the-shop" parts and materials.
- LOCTITE will withstand temperatures up to 300°F.

LOCTITE Sealant makes a slip fit as strong as a press fit, a press fit stronger. It can be used to relax tolerances and to improve reliability.

Wherever metals are LOCKED-RETAINED-SEALED there is an opportunity to cut costs and increase profits with LOCTITE. Details on your application bring immediate response from our Application Engineering Department. Write today.



LOCTITE BEALA

AMERICAN SEALANTS COMPANY 111 North Mountain Road . Hartford 11. Connecticut

you manufacture:

air conditioning appliances electronics communications electrical apparatus fans

blowers

machine tools
materials handling
panelboards and
switch boards
prime movers
pumps
compressors
general machinery

these Westinghouse products are tailored for you

On these pages are shown some of the many components developed and manufactured by Westinghouse specifically for OEMs. Here is one single source for technical assistance, manufacturing and stocking of all of your electrical needs. Use this total service to solve your design and manufacturing problems now. Call your local Westinghouse Sales Engineer or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse



NEW



permanent magnet runout table motors

Improved performance, more torque per ampere, high temperature insulation. This watertight motor is designed specifically for starting, stopping, and reversing of rugged steel mill machinery and equipment. Epoxy insulation system provides full protection, highest resistance to corrosive agents and retains mechanical flexibility throughout its life. Write for Bulletin B-8247. Westinghouse Electric Corporation Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse



DESIGN ABSTRACTS

tion advantages.

SAWE Technical Paper No. 286, "The Current Trends of Threaded Fastener Weights in Aerospace Vehicles," presented at the 20th National Conference, SAWE, Akron, Ohio, May, 1961, 8 pp.

Bending of a Thin Cylindrical Shell

H. R. Meck, Design Engineer, Connecticut Aircraft Nuclear Engine Laboratory, Pratt & Whitney Aircraft, Middletown, Conn.

Analysis of the bending of a thin circular cylindrical shell under a varying radial line load distributed around the circumference at the center section.

The problem is solved by reducing the eighth-order differential equation of thin-shell theory to two approximate fourth-order equations. Deflections, bending stresses, and membrane stresses are evaluated. Both simply supported and clamped ends are considered.

ASME Paper No. 61-APM-15, "Bending of a Thin Cylindrical Shell Subjected to a Line Load Around a Circumference," presented at the Summer Conference of the Applied Mechanics Division, Chicago, June, 1961, 7 pp.

hydraulic

Piston-Bore Clearance In Small Compressors

H. J. Smith, Senior Lecturer in Applied Thermodynamics, Brighton Technical College, England.

An investigation into the effect of piston diametral clearance on the performance of a small refrigeration compressor to determine the limiting conditions for satisfactory performance.

Six pistons of standard ringless design were used in the same compressor, giving clearances ranging from 0.0004 to 0.0041 in. The tests were carried out on a refrigerator with a calorimeter-type evaporator using dichlorodifluoromethane.

Both volumetric efficiency and specific power were found to vary greatly with the clearance, the former being greatest with the minimum clearance but the latter showing a tendency under some conditions to a minimum value for a diametral clearance of 0.0022 in. Honed cylinders and ground pistons

NEW



totally enclosed a-c motors

15% increased capacity, 80% to 100% longer life at rated loads. Totally enclosed motor with Class "B" insulation for greater performance life, lower maintenance under toughest conditions. Available as standard on 1 hp to 250 hp sizes in famous Life-Line "A" design. For information, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse



Circle 502 on Page 19

NEW



STATIC SLIPSYN synchronous motor control

No moving parts, precise synchronizing control up to 99% of synchronous speed. Static networks eliminate corrosion and wear failures. Positive adjustable pull out protection avoids false tripping. Static damper winding, field loss and incomplete starting sequencing protection available. For new or old motor control installations. For details, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse (





tb1* switchboard instruments

No friction, higher sensitivity, in-fallible repeatability, unaffected by shock or vibration (can be shipped installed in equipment). These new Westinghouse K-241 and K-251 Taut Band Suspension instruments available in 41/2 full view 250° scale or 6" rectangular 100° scale designs. Meet or exceed ASA Standard C-39.1. For sample of TBS and Bulletins 43-240 and 43-250, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure ... if it's Westinghouse.

Westinghouse



Circle 504 on Page 19



VOLTRAP* surge suppressor

Positive surge protection for silicon and germanium devices: Available in 16 ratings from 30 to 480 volts rms; clamping voltage range either 250% or 280% of rms voltage rating; 8 discharge ratings, 2 to 80 amps; polarized or non-polarized units. Write for TD 19-163. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Circle 505 on Page 19

Westinghouse



are considered essential for good performance.

It is suggested that in addition to piston leakage, entry heating plays an important part in the reduction of volumetric efficiency.

IME Preprint No. 43/60, "Effect of Piston/Bore Clearance In Small Refrig-eration Compressors," 12 pp.

Prestressed Spherical Pressure Vessels

G. B. Wills and S. A. Dunn, Bjorksten Research Laboratories, Madison, Wis., and H. R. Worthington Jr., Scientific Engineering Institute, Cambridge, Mass.

How theoretical bursting pressure of a thick-walled spherical pressure vessel can be greatly increased by incorporating an initial stress distribution into the wall prior to pressurization.

Prestress can be achieved by utilizing continuous filament-wound wall construction and controlling the tension with which the filament is laid onto the vessel. The programing of fiber tensions which will produce the optimum prestress pattern is analyzed and described by suitable equations for several general cases of interest.

SAMPE paper, "Prestressed Spherical Pressure Vessels," presented at the SAMPE Filament Winding Symposium, March, 1961, Symposium Papers pp. 282 to 300.

bearings

Gas-Lubricated Bearings Under Static Loading

B. Sternlicht, General Electric Co., Schenectady, N. Y.

Numerical solutions of the Reynolds equation for finite length, gaslubricated cylindrical journal bearings under static loading (this corresponds to a load of constant magnitude and direction with respect to the bearing).

It is shown that the incompressible results are but only limiting cases to the more general compressible solutions. The results of the two solutions are dovetailed together through the use of two dimensionless parameters: The inverse of the Sommerfeld number and the compressibility number. Comparisons of the iterative solutions and the firstorder perturbation and the "linear-



magnet direct current brake

For all applications that require fast stopping of the motor and load. Available in six wheel sizes, 8" to 23" meets all AISE standard dimension requirements. Uses twin magnet epoxy encapsulated coils, has six integrated compact sub-assemblies and requires only two easy adjustments for shoe wear and spring tension. Write for B-8248. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse.

Westinghouse



Circle 506 on Page 19



economy K-221 tbs* switchboard instruments

Famous TBS features, plus new economy. Lowest priced high quality switchboard instrument available today. Taut Band Suspension K-221 instruments offer permanent accuracy and are unaffected by shock or vibration (even shocks caused by shipping installed in equipment). Meets or exceeds ASA Standard C-39.1. For TBS sample and Bulletin 43.220, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. *Trademark





design with



in mind

A big, wide world of new ideas opens up when you design with Danco in mind. Danco's custom molded thermoplastics and tubing, pipe, rod and strip — extruded in Nylon and other plastics — overcome old obstacles . . . bring closer exciting achievements in design.

Danco extrusions are ideal for many applications because they are self-lubricating . . . tough . . . long-wearing . . . non-corrosive . . . and practically frictionless. Many jobs can be done better and at lower cost with reliable Danco tube, pipe, rod or strip. Faster delivery from large stock.

design ideas - briefly.

Economical, non-corrosive DANCO TUB-ING and PIPE for carrying air, cold water, blood, gasoline, and food and milk.

Gears, bushings, bearings and other machine parts are readily machined to close tolerances from DANCO ROD and HEAVY WALL TUBING.

Washers, gaskets, and a variety of flat parts can be stamped from DANCO STRIP on high speed stamping equipment.

NYLON-COATED INDUSTRIAL CABLE in a wide variety of sizes for many applications such as belt lacing, drawing board cables, manual controls, artificial limbs, etc.

If you are designing, keep Danco in mind. Our experienced, trained field engineers can help right from the start.

CUSTOM MOLDED PARTS A pioneer in molding Nylon as well as other engineered thermoplastics, Danco offers complete custom molding service and production.

FREE — write today for this fact-filled catalog.





THE DANIELSON MANUFACTURING COMPANY

A Subsidiary of Nicholson File Company
ARMS AVENUE, DANIELSON, CONNECTICUT

Circle 317 on Page 19

DESIGN ABSTRACTS

ized ph" methods are made. The advantages and disadvantages of these methods of analysis are discussed.

ASME Paper No. 61-APM-17, "Gas-Lubricated Cylindrical Journal Bearings of the Finite Length," presented at the Summer Conference of the Applied Mechanics Division, Chicago, June, 1961, 9 pp.

management

Mechanized Retrieval of Scientific Information

Vida Grace Hildyard, staff consultant to the director, Engineering Services, Remington Rand UNIVAC, Div. of Sperry Rand Corp., St. Paul, Minn.

Considerations in the establishment of mechanized systems for information storage and retrieval.

Regardless of capabilities, mechanized systems cannot retrieve information not properly indexed in the first place. Consequently, recent emphasis has shifted somewhat from machine design to theory of indexing and retrieval.

The three most prominent indexing philosophies which have been developed are the Uniterm system of Mortimer Taube, the descriptor concept of Calvin Mooers, and the "role indicator" method of Western Reserve University.

For indexing purposes, Taube advocates using the key words which actually appear in the document itself. Mooers' system uses as "descriptors" the basic concepts with which the document is concerned. Western Reserve goes a step further than either of these, conveying the relationship between terms and ideas by means of "role indicators." Another philosophy, particularly valuable for certain types of subject matter, embodies hierarchical classifica-

ASQC Paper No. 61-138, "Mechanized Retrieval of Scientific Information," presented at the 15th Annual Convention, Philadelphia, June, 1961, Transactions, pp. 353 to 358.

How to Educate Engineers To Use Digital Computers

J. L. Davie, McDonnell Automation Center

On-the-job training of engineers —a report of one company's efforts.

A RELIABLE PLUG-IN 25 AMP RELAY



More compact than most 10 amp relays

With "Diamond H" Series W dpdt relays you can fit as many as fourteen 25-amp circuits into a space measuring only $1\frac{1}{2}$ " x $1\frac{7}{2}$ " x $11\frac{1}{2}$ "!

Easy to install or remove—Spade terminals for socket or quick-disconnect installation. Solder terminals available.

Long, trouble-free service—Simple, functional construction with oversized solid silver contacts and contact bar assure long-time, dependable switching. Series W relays have given well over a million cycles at a 15-amp load.

SPECIFICATIONS

CONTACTS:

Arrangement—dpdt, double break, double make. Other arrangements and sequences.

Load—25 amp resistive, 120 or 240 V a-c 25 amp ind., 120 V a-c (75% p.f.) 12½ amp ind., 240 V a-c (75% p.f.) 1 hp 120 V a-c, 2 hp 240 V a-c 25 amp resistive 28 V d-c

MOUNTING: Panel, side or socket DIMENSIONS: $1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{7}{8}$ inches. U/L APPROVAL: U/L File 31481

COMPLETE DATA and specifications are available—new 8-page Relay Guide.



MANUFACTURING COMPANY

118 Bartholomew Avenue, Hartford 1, Conn.
Phone JAckson 5-3491

One of the critical areas where additional training is necessary is in the field of electronics and electronic equipment. This includes the applications of computers.

Three major problems are:

- What subjects should be offered and how should they be presented.
- How to find people qualified on the subject and train them in their duties as instructors.
- How to present the material in such a way that this captive audience will feel they are not wasting their time.

The following educational system is recommended:

- Hold periodic seminars for middle and top management to keep them informed on the present status of data processing equipment.
- Provide training classes for supervisors in which the main subject is present computer applications and possible future application areas.
- Offer training classes for the engineer who is actively engaged in the area of work where applications exist.

SAE Paper No. 372B, "How Industry Educates Engineers To Use Digital Computers," Summer Meeting, St. Louis, June, 1961, 4 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to: AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ASQC—American Society for Quality Control, Room 6197, Plankington Bldg., 161 West Wisconsin Ave., Milwaukee 3, Wisconsin.

IES—Institute of Environmental Sciences, P. O. Box 191, Mt. Prospect, Ill., Proceedings of the 1961 National Meeting, 684 pp., nine dollars per copy to members, 14 dollars per copy to nonmembers.

IME—The Institution of Mechanical Enginers, 1 Birdcage Walk, Westminster, London S.W. 1, England.

ISA—Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

SAE—Society of Automotive Engineers, 485 Lexington Ave., New York 17, N. Y; papers 50 cents to members, 75 cents to nonmembers.

SAMPE—Society of Aerospace Material & Process Engineers, P. O. Box 613, Azusa, Calif.

SAWE—Society of Aeronautical Weight Engineers Inc., 1051 Second Ave., Chula Vista, Calif.

Westinghouse Engineer, P. O. Box 2278, 3 Gateway Center, Pittsburgh 30, Pa.; individual copies 50 cents.

VERSATILE is the WORD!

The big
difference in
Sheet Metal Cabinetry
for Electronics
and Instrumentation
is offered only

by Equipto





SAG-PROOF DOORS

All doors are mounted flush and recessed within the frame members. Doors are removable and are mounted with heavy-duty separable hinges with a ½" stainless steel pin and nylon anti-friction bearing. They can be mounted just as easily on sides as on front or back.



MOVABLE SIDE STRUTS

Horizontal side frame members can be moved and re-installed or completely removed to suit specific requirements of the user. Side members need no longer interfere with cabling between cabinets, impede air flow, or create other unnecessary difficulties.

Get the Facts! Write today for descriptive Brochure No. 100.

See us at the National Electronics Conference—Booth 744



Equipto ELECTRONICS CORPORATION

319 NORTH WEBSTER STREET · NAPERVILLE 1, ILLINOIS



A BETTER SHAKE FOR POLARIS... Aerojet-General installs Ling vibration system with world's highest force rating -60,000 pounds

When faced with unsolved vibration testing problems on its vital part of the Polaris program, Aerojet-General Corporation, a subsidiary of The General Tire and Rubber Company, turned to Ling Electronics. To give its solid propellant rocket engines the severest shake-up, Aerojet-General improved its test facilities with two Ling vibration systems—controlled simultaneously or independently by one console. The system, now operating, includes two Model 249 shakers delivering 30,000 pounds force each and two Model PP 120/150, 120 KVA water-cooled amplifiers—for a total force delivery of 60,000 pounds. The special random/sine wave console not only provides simultaneous or independent control of both exciter systems, but features Ling's famous ESD-ASD 20 spectral density equalizer/analyzer, the industry standard. Like Aerojet-General, you too may find the superior quality and rugged reliability of Ling systems answer your testing problems. For more information, write Department MD-961 at the address below.



LING.TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA . PRospect 4-2900

The powerful Ling vibration system shown at the left is just one more example of the way Ling's continuing program of research serves industry and defense programs.

As package weights rise, so does the need for vibration testing systems of higher performance and reliability. And Ling engineers have consistently anticipated these demands with designs that keep pressing toward higher ratings.

The powerful Model 249 shaker shown below delivers 30,000 pounds of force when combined with its mating amplifier. Only the high force rating of the 249 shaker made it possible to meet the big systems needs of Aerojet-General as described at the left.

Ling amplifiers offer equally impressive ratings. Ling pioneered in the manufacture of electronic amplifiers for driving electro-dynamic shakers and has produced liquid-cooled amplifiers that deliver from 10,000 to 5,000,000 watts.



Listed below are performance ratings of high power Ling vibration systems employing the Model 249 shaker:

LIQUID-	LIQUID-	FORCE	FORCE
COOLED	COOLED	LBS.	LBS.
SHAKER	AMPLIFIER	SINE	RANDOM
249	PP 175/240	30,000	32,000
249	PP 120/150	30,000	28,000
249	PP 75/90	23,000	21,000

Whatever your needs in high power electronics—vibration testing, acoustics or sonar, you'll find Ling systems offer high performance, high reliability, and quality that sets the standard.



LING.TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Ammonia Valves

Describes 292 different ammonia valves designed for refrigeration, L-P gas service, and general industrial applications. Places emphasis on ductile-iron valves. Also covers neck flanges, pressure-relief, flow-check, and hand-expansion valves, strainers, liquid-level gages, charging-hose sets, quick-disconnect couplers, forged-steel unions, and flanged unions. Catalog 203, 12 pages. Henry Valve Co., 3215 W. North Ave., Melrose Park, Ill.

Circle 601 on Page 19

Recycling Timer

Describes compact recycling timer, Series Dual-Trol. Covers operation of the unit, and includes pertinent electrical and mechanical parameters needed to adapt the device to a variety of control applications. Bulletin 501, 2 pages. Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J.

Circle 602 on Page 19

Photographic Line

Devoted primarily to engineering and other industrial photographic papers and films, booklet also describes projection materials for engineering, offset printing, microfilms, and related uses; direct-positive papers and films; multiple-copy photocopying papers and processing solutions; 27, 12, and 9-in. diffusion transfer processors; and various darkroom and processors; and various darkroom and processing-machine developers, fixers, and other solutions. Contains a comparison chart on more than 30 contact and projection papers and films. Anken Chemical & Film Corp., Newton, N. J.

Circle 603 on Page 19

Portable Testing Instruments

Lists line of portable units, with complete data on models, accuracies, ranges, features, and prices. Included are matched ac and dc industrial meters, a portable current transformer, dc portable units for laboratory needs, and multipurpose industrial instruments. Bulletin Z-54, 8 pages. Weston Instruments Div., Daystrom Inc., 614 Frelinghuysen Ave., Newark, N. I.

Circle 604 on Page 19

Beryllium Bolts

Contains review of the development of the first beryllium structural bolting. Traces the discovery of the metal and the early exploration of its properties. Discusses headed and threaded fasteners of beryllium with high impact and fatigue performance. Form 2719, 16 pages. Standard Pressed Steel Co., Box 102, Jenkintown, Pa.

Circle 605 on Page 19

Plastic Caps and Sleeves

Announces the availability of largersize protective polyethylene caps and sleeves to safeguard threaded shafts, drill pipe, and other products and components of relatively large diameter or odd shape. Includes illustrations indicating some design possibilities for the caps and sleeves which can be molded in practically any shape or depth. 2 pages. Caplugs Div., Protective Closures Co. Inc., 2207 Elmwood Ave., Buffalo 23, N. Y.

Circle 606 on Page 19

Heat-Resistant Adhesive

Covers line of color tints and shading films, illustrates different types, patterns, and colors available. Printed on pressure-sensitive, heat resistant Mylar film, material is available in 132 patterns and 27 different colors. Describes translucent white and black sheets for use in making slide presentations. 6 pages. Transograph Div., Chart-Pak Inc., Leeds, Mass.

Circle 607 on Page 19

Metallized Ceramics

Presents data on properties of ceramic compositions most frequently used as metallized or ceramic metal adjoinments. Discusses low and high-temperature metallizing; electroplatings, dips, or coatings; design and installation instructions for ceramic-metal assemblies. Lists low and high-temperature items available from stock, and includes several tables of brazes, solders, and metals used in assemblies. Bulletin 612, 16 pages. American Lava Corp., Chattanooga 5, Tenn.

Circle 608 on Page 19

Integral-Horsepower Motors

Describes full line of ac general-purpose, integral-horsepower motors available for all standard voltages and frequencies. Contains selection and specification tables, mounting-arrangement drawings, speed-torque curves, principal dimensions, and pictures a number of designs developed for special uses. Bulletin L-3314A, 6 pages. Kingston-Conley Inc., Plainfield, N. J.

Circle 609 on Page 19

STOW FLEXIBLE SHAFTING The Ideal PTO Drive



11/4" flexible shaft under tractor-trailer transmitting 10 HP.



11/4" core assembly pulled out of casing. Note steel-backed bronze sleeve bearing.

Here are five big reasons why flexible shafting is an ideal power take-off drive on trucks and tractor trailers.

FLEXIBLE SHAFTING:

- 1. Can connect a drive shaft and a driven shaft which are working at different angles and located in different planes.
- 2. Eliminates the need for accurate alignment. 3. Eliminates dangerously exposed revolving parts; no safety guards required.
- 4. Replaces connections affected by vibration. 5. Is economical because it is so easy to install and maintain.

Available with built-in bearings and couplings in sizes from 1/4 inch to 11/4 inches in diameter-STOW flexible shafting can help solve your trucking and maintenance problems in advance. The know-how of 85 years' experience goes into every STOW flexible shaft! STOW flexible shafts are being used

on trucks and tractor-trailers to:

- Operate pumps for petroleum, other liquids and hydraulic pumps on dump trailers.
- · Operate conveyors for grain and
- · Operate compressors on refrigeration trucks.

Our Engineering Department will be glad to work with you on any special drive problems. For complete data on flexible shafting sizes, torque capacities, and other specifications, write for STOW Engineering Bulletin, No. 570, and Tractor-Trailer Bulletin, No. 542.

STOW MANUFACTURING CO.

11 Shear St.

Binghamton, New York

HELPFUL LITERATURE

Glass Fiber-Reinforced Pipe

Provides detailed technical and specification data on Fibercast centrifugally cast, thermoset epoxy resin, glass fiber-rein-forced pipe developed to handle special pressure and corrosion problems. Includes chemical-resistance data, specifications, charts relating to Fibercast line pipe and tubing, and general engineering data. 16 pages. Fibercast Co., Box 727, Sand Springs (Tulsa), Okla.

Circle 610 on Page 19

Tape Recorder-Reproducer

Gives data on VR-2600 wide-band, magnetic-tape recorder-reproducer. Unit is an integrated, multichannel, data recording and reproducing system handling precision data in the frequency spectrum from dc to 500 kc. Bulletin 2600, 4 pages. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 611 on Page 19

Wound-Rotor Motors

Ranging in size from 1 to 30 hp, new motors meet the requirements of any wound-rotor application including elevators, cranes, hoists, or printing presses. Construction details, dimensions, and specifications are provided. Bulletin 104, 4 pages. Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

Circle 612 on Page 19

Sheets, Rods, Tubes

New technical data on line of laminated epoxy sheets, rods, and tubes are presented. Listed in the sheet laminates are four grades of glass-fabric epoxy and one paper epoxy, including new Dilecto 614. Information is supplied on typical electrical and mechanical properties, sizes, and thick-Technical Bulletin 11,200B, 6 pages. Continental-Diamond Fibre Corp., Newark, Del.

Circle 613 on Page 19

Transparent Tubing

Covers selection of Busada 200 transparent plastic tubing for every application. Charts show physical characteristics of Tenite Butyrate, the plastics compound used to make the tubing, tubing tensile strength vs temperature, impact strength vs temperature, plus table of standard sizes. 4 pages. Busada Mfg. Corp., 32-21 Downing St., Flushing 54, N. Y.

Circle 614 on Page 19

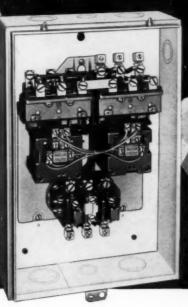
Quick-Connect Couplings

Two bulletins contain complete specifications and details on E and H quick connect-disconnect couplings. They include a catalog of spare parts, accessories, and suggested methods of using the couplings. Bulletins 240-61 and 250-61, 8 pages. Snap-Tite Inc., Union City, Pa.

Circle 615 on Page 19

How's this for SATISFYING YOUR REVERSING SWITCH PROBLEMS!







BULLETIN 705 SIZE 2 Revers ing Starters—Available in Seven Sizes with Maximum Ratings up to 100 HP, 220 V; 200 HP, 440-550 V.

Open or Enclosed-THEY SAVE SPACE WHERE IT COUNTS MOST

Listen to this-all new "open type" A-B reversing switches have the overload relays mounted at the sides as shown-ideal construction for panel channel wiring. It fits with A-B contactors and starters of the same rating. The over-all width for each rating is also appreciably less than it was with the old Bulletin 705.

All new enclosed A-B reversing switches have the overload relays (either 2 or 3) mounted as a "block" below the reversing switch. This permits a narrow enclosureideal for most mountings on machine tools.

Rating for rating, the new Allen-Bradley reversing starters will set new records for long, trouble-free life. The new structure is so simple and so sturdy that nothing can go wrong. If you have a particularly tough service application, try the new A-B Series K reversing switches-and live happily ever after.

You'll like the new line of modern, attractive enclosures, too. Brooks Stevens, internationally known industrial designer, has given them that extra "eye appeal" - which is an asset for every installation.

For complete information on these new reversing switches, please write today for Publication 6100, Allen-Bradley Co., 1316 S. Second Street, Milwaukee 4, Wisconsin.



Size 1 Combination Reversing Starter-available with fused or unfused manual disconnect switch, or as Bulletin 707 with circuit breaker.

ALLEN-BRADLEY

QUALITY **MOTOR CONTROL**

The Superior "Quality" of the New Allen-Bradley Starters GREW OUT OF DESTRUCTIVE TESTS

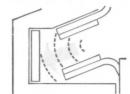
Tests which subject starters to far more severe conditions than heavy-duty service are "routine" at Allen-Bradley and provide data for improved starter design

There was no question about the "quality" of the old Bulletin 709 starters but—the new line is far superior. With their built-in "extra" interrupting capacity, each rating of the revolutionary new Allen-Bradley motor starters can operate with ease at maximum rated capacity for prolonged periods—and still have more than ample reserve for emergency conditions. The new, totally enclosed arc hoods are hot molded of a material having unusual arc quenching properties. In addition, powerful arc blowouts and wrap-around metal quenchers assure fast, efficient arc extinction and heat dissipation. There are many other features about this new line that you ought to know. Therefore, please write for Bulletin 6100, today! Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.



Here's How EXTRA Interrupting Capacity Is Built Into All Allen-Bradley Starters

Powerful Arc Blowout



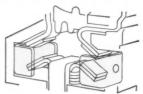
The powerful magnetic field, generated between the contacts when an arc is drawn, forces the arc off the end of the contacts. It is quickly cooled and extinguished by the large surfaces of the hood.

Totally Enclosed Chambers



A new, unusually strong and stable material is hot molded to extremely close tolerances. Each chamber of the arc hood is totally enclosed. Thus, the usual effects of ionization and heat are greatly minimized.

Metal Arc Quenchers



Size 2 starters and the higher ratings have metal quenchers in both the front and back of each arc chamber. This efficient construction gives the arc no chance to become destructive.

17-61-MR

ALLEN-BRADLEY

QUALITY MOTOR CONTROL

Heat-Transfer Problems

Gives graphical solutions in Btu per sq ft per hr and w per sq ft versus temperature difference to all types of heat-transfer problems. Heat-transfer design manual also contains data on heat-transfer coefficients and specific heat and thermal conductivities. Design Manual HDM-761, 12 pages. Electrofilm Inc., 7116 Laurel Canyon Blvd., North Hollywood, Calif.

Circle 616 on Page 19

Dry Fluid Drives

Gives a simplified method for selecting Flexidyne dry fluid drives and couplings for most industrial applications. Eight stock drives and 11 stock couplings are covered for fractional to 1000-hp requirements. Includes tables of weights and dimensions tables of recommended V-belt drives for use with units of various sizes. Bulletin 70, 20 pages. Dodge Mfg. Corp., Mishawaka, Ind.

Circle 617 on Page 19

Air-Hydraulic Cylinders

Improved Series CLA, 11/8 in., clamptype cylinders are available for 150 psi air and 250 psi hydraulic service. Construction features, dimensions, special features, typical applications, and accessories are presented. Catalog 861, 6 pages. Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 618 on Page 19

Solderless Terminal Blocks

Connecto-Block solderless terminal blocks are for use in communications, data-processing, and broadcast equipment. Male terminals on the boards mate with snap-on solderless terminals. Boards function in audio, control, video, and pulse circuits. Cost and space saving features are detailed. Bulletin K 2-5, 4 pages. Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.

Circle 619 on Page 19

Teflon Products

Shows many products of Teflon and processing operations, as well as Salox formulations containing reinforcing agents. Includes new Teflon and Salox X-Seal rings, O-rings, back-up rings, packings, molded parts, extrusions, and machined parts. Bulletin R3017, 8 pages. Allegheny Plastics Inc., Coraopolis, Pa.

Circle 620 on Page 19

Spring Washers

Illustrates and lists Belleville, sawtooth Belleville, arc, three-wave, and other types of spring washers for selection by type or size. Includes information on spring-washer characteristics and embrittlement-free, zinc-plating process. Bulletin SW-2, 8 pages. Dept. SW-2, George K. Garrett Co. Inc., Torresdale Ave. at Tolbut St., Philadelphia 36, Pa.

Circle 621 on Page 19



FAST DELIVERY ON LARGEST ALLOY ROUNDS AND FLATS

Here's the speedy source of really big alloy steel shapes that can eliminate your storing and handling costs. Seven strategically located Wheelock, Lovejoy & Company, Inc. warehouses provide prompt service on HY-TEN alloy rounds up to 18" diameter and flats up to 16" thick and 24" wide. Rounds can be supplied smooth-turned ½" oversize. They're also available hot-rolled or forged to size in the annealed or heattreated condition. Flats may be supplied forged, normalized, and heat-treated. For complete, fast, satisfactory service, call the W-L branch warehouse nearest you.

W.L. STEEL SERVICE CENTERS—Cambridge • Cleveland Chicago • Hillside, N. J. • Detroit • Buffalo • Cincinnati AGENTS—Southern Engineering Company, Charlotte, N. C.; Sanderson-Newbould, Ltd., Montreal & Toronto

"The Alloy Steel Center"



WHEELOCK,
LOVEJOY

134 Sidney St., Cambridge 39, Mass. SERVICE CEN

New! Redesigned M-D
HEAVY-DUTY
BLOWERS...

M-D BLOWERS ARE BETTER THAN EVER! 12 new features have been added to make M-D blowers even more rugged and reliable and to guarantee positive oil-free flow under the most severe operating conditions. These improvements plus M-D's exclusive 3-lobe rotor design (which eliminates the possibility of rotor deflection at high speeds) permit operation at constant pressures up to 15 PSIG in single-stage and to 70 PSIG in multi-stage with capacities ranging from 30 to 4000 CFM.

SPECIFY M-D ROTARY POSITIVE BLOWERS FOR: Smallest Cube Dimensions • Widest Pressure Range • GUARANTEED Flow (Factory Tested). Oil-Free Air Flow



Write for new free descriptive literature

M-D BLOWERS, Inc.

Racine, Wisconsin



Aluminum Ingot

Features data on one new composition and two alloys previously unavailable in ingot. Brochure gives data on material selection and extruding pressures to heat-treatment of the finished parts. Details chemical composition limits, characteristics, typical uses, mechanical properties, and recommended thermal treatment. Form 28-11596, 12 pages. Aluminum Co. of America, 726 Alcoa Bldg., Pittsburgh 19, Pa.

Circle 622 on Page 19

Pump Fundamentals

Gives an elementary, nontechnical outline of the characteristics, operation, and selection of reciprocating, rotary, and centrifugal pumps. Emphasis is placed on centrifugal pumps. Definitions, basic formulas, examples, and miscellaneous data used in pump application are included. Form 5773-J, 16 pages. Goulds Pumps Inc., 226 Black Brook Rd., Seneca Falls, N. Y.

Circle 623 on Page 19

AC Motors

Describes ac general-purpose motors for driving such machines as compressors, pumps, high-inertia fans and blowers, refrigerators, air conditioners and machine tools. Presents selection and specification information, mounting arrangements, performance curves, and lists principal dimensions. Illustrates a variety of special designs available. Bulletin L-3313A, 6 pages. Kingston-Conley Inc., Plainfield, N. J.

Circle 624 on Page 19

Spacer Bushings, Washers

Provides complete information on 259 sizes of hardened and ground steel spacer bushings, and lists some applications. Also covers decimal and inch-dimension steel thrust washers. 4 pages. Detroit Ball Bearing Co., 110 W. Alexandrine, Detroit, Mich.

Circle 625 on Page 19

Dial Timer

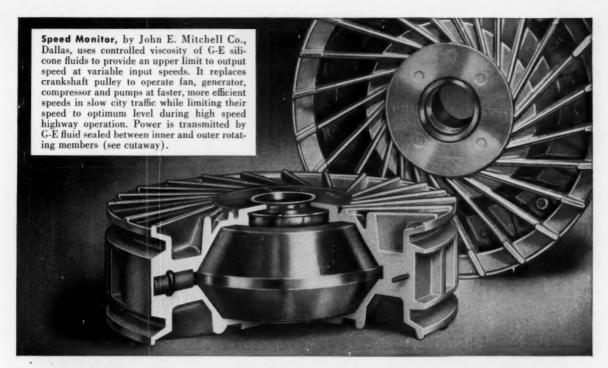
Includes data on construction, installation, application, specialized functions, electrical data, and basic circuit arrangements for Series 305B automatic-reset dial timer. Bulletin N-305B, 8 pages. Automatic Timing & Controls Inc., King of Prussia, Pa.

Circle 626 on Page 19

Indicator Tubes

Describes new wide viewing-angle series of Nixie tubes. Covers circuit-design criteria for the tubes, and contains detailed suggested circuits for their use in various types of electro-mechanical and electronic systems. Five wide-angle Nixie tube types are discussed. 8 pages. Electronic Components Div., Burroughs Corp., P. O. Box 1226, Plainfield, N. J.

Circle 627 on Page 19



GENERAL ELECTRIC SILICONE FLUIDS

for reliable performance under tough operating conditions



Temperature, Deg C



Thermal stability. The outstanding thermal and oxidative stability of G-E silicone fluids, over an operating temperature range of -100°F to 600°F, makes them suitable for such rigorous applications as jet engine lubricants and aircraft hydraulic fluids. G-E Versilube fluids give unequalled performance at high temperatures and are comparable to other hydraulic fluids in moderate ranges.

Nearly constant viscosity over wide temperature range. G-E silicone fluids exhibit very small changes in viscosity with wide temperature variations. This makes them ideal for many mechanical applications, including fluid drives, dash pots, vibration dampers, timers, shock absorbers, or wherever constant viscosity is needed.

Get the complete story. These bulletins give complete technical data on the G-E silicone fluid line and describe many of the ways in which designers are taking advantage of their outstanding properties. For your free copies, write to Department WW953, General Electric Co., Silicone Products Department, Waterford, N. Y.

GENERAL



ELECTRIC

AVISUN DOLYPROPYLENE GIVES "FORM-FIT" COMFORT

First Injection Molded

For this major advance in furniture making, Alladin Plastics, Gardena, Cal., uses AviSun polypropylene. Here's why: • Amazing strength—In Alladin's thumping, rocking torture test, AviSun Impact Grade Polypropylene outlasted all materials tested—endured up to 375 times longer. • Supple comfort—like that of

upholstered furniture. • Chemical and stain resistance—to detergents, alcohols, oils, foods and cleaners—unharmed by sun and weather. • Mold cycles—as fast as 60 seconds with no post-mold aging. • Get the facts on how polypropylene can upgrade your product from: AviSun Corporation, 1345 Chestnut Street, Philadelphia 7, Pa. • In Canada: Courtaulds, Plastics Canada, Limited.



*Trademark of AviSun Corp.

Why AVISUN polypropylene was chosen



Toughness and resiliency of polypropylene give the Alladin chair the ability to shrug off all kinds of rough handling.



Polypropylene's tensile strength, inherent in the material and easily designed into the chair, was highest by actual test over all competitive materials.

hair



Because polypropylene is lightest of the plastics, the chair can be carried about with ease by any member of the family.

Disc Indicators

Detailed information on disc indicators used in measuring and control systems employing resistance strain-gage transducers is presented. Includes specifications, connection details, diagrams showing typical system applications, and disc indicator selection chart. Bulletin 4410, 6 pages. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.

Circle 628 on Page 19

Teflon-Lined Rubber Tubing

Describes 1-RR Teflon-lined rubber tubing, which combines the electrical properties, chemical inertness, low coefficient of friction, and wide service-temperature range of Teflon with the elasticity, scuff resistance, and thermal protection of neoprene. Tubing prevents Teflon from kinking or abrading in service. 2 pages. Pennsylvania Fluorocarbon Co. Inc., 115 N. 38th St., Philadelphia 4, Pa.

Circle 629 on Page 19

Rod Wipers; O-Rings

Two bulletins provide complete data on new lines of solid-polyurethane hydraulic components. One covers urethane rod wiper/scrapers, the other, urethane Orings. 4 pages. Disogrin Industries, Div., Pellon Corp., 510 S. Fulton Ave., Mt. Vernon, N. Y.

Circle 630 on Page 19

Trimming Potentiometer

Microminiature, $\frac{3}{8}$ -in. square trimmer weighs $\frac{3}{4}$ gram and has a power rating of 1 w at 50 C, derating to zero at 175 C. Catalog describes electrical, mechanical, and environmental characteristics, includes also charts for resolution, power rating, and representative prices. 2 pages. Techno-Components Corp., 18232 Parthenia St., Northridge, Calif.

Circle 631 on Page 19

Synchronous Motors

Describes construction and operation of 385 different types and models of synchronous motors with ratings from 1/2000 to 1/6 hp. Includes speed-torque curves, dimensional drawings, wiring diagrams, and performance characteristics. Bulletin 1036, 20 pages. Bodine Electric Co., 2500 W. Bradley Place, Chicago 18,

Circle 632 on Page 19

Temperature Transmitter

Gives information on Type 12A pneumatic temperature transmitter with automatic compensation for ambient temperature and pressure changes. Illustrates how transmitter is installed and adjusted to suit a range of application requirements. Also included are detailed specifications, descriptions of operating principle, table of temperature ranges, and data on re-lated accessories. Bulletin 13-17C, 12 pages. Foxboro Co., Foxboro, Mass.

Circle 633 on Page 19

Versatility IN VULCAN STRIP HEATERS

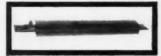


Vulcan Strip Heaters have almost unlimited application for heating any smooth, dry surface to which they can be bolted or clamped - dies, platens, molds, etc. They can also be mounted for comfort and process air heating applications.



BAND HEATERS

Latest development in the Vulcan heating line, Band Heaters are especially applicable for plastic molding and extruding machines, tanks, pipelines, autoclaves, and similar uses. An aluminized steel sheath, together with a special alloy tight-gripping clamping band, assures long life. Wide range of diameters.



FINNED HEATERS

Finned heaters provide six times more effective heat transfer surface than standard strip heaters for air duct heating, blowers, unit convection heaters,

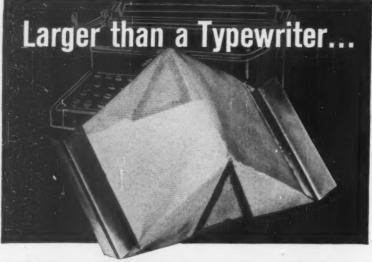
Send for Catalog VG-201 containing specifications and prices.



VULCAN ELECTRIC COMPANY, Danvers, Mass.

241

WIRE CLOTH PARTS





Each has this common denominator SKILLED CRAFTSMANSHIP

And this same common denominator runs throughout all of NWC Fabricated Wire Cloth Inserts and Parts, as well as throughout the broad range of Newark wire cloth itself.

It takes particular skill to turn out tiny inserts such as the smaller of the two illustrations above...not only skill in actual handling but skill in devising the special methods by which they must be made. We have applied these skills to hundreds of inserts, required for instrumentation, electronic controls and equipment of many types.

Can we be of service to you? Perhaps we can help in the design. We should be able to make anything you require—with the skill that comes from years of experience.





351 Verona Avenue • Newark 4, New Jersey Teletype: NK607 • Tel.: HUmboldt 3-7700

Representatives in all principal industrial areas

Ratchet-Wrench Applications

Introduces manufacturers of machinery and original equipment to a wide variety of uses for ratchet wrenches as component parts or as functional accessories. Photographs illustrate successful uses for standard and special wrenches. Form C-52, 6 pages. Lowell Wrench Co., Worcester 4, More

Circle 634 on Page 19

Plastic Protectors

Describes flexible vinyl round caps which provide protection for tubing, machine-screw threads, and pipe threads. Includes data on dimensions and types available. Bulletin 6104-VP, 4 pages. S. S. White, Plastics Div., 10 E. 40th St., New York 16, N. Y.

Circle 635 on Page 19

Panel Meter

Covers Style 42, 4½-in., rectangular panel meter. Shows photographs, features, outline drawings, standard specifications, and modifications available. Also lists 95 standard models of voltmeters, ammeters, milliammeters, and microammeters. 2 pages. Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.

Power Supplies

Permits exact specification of power supplies to match required output, input, frequency range, and/or other parameters. Catalog is organized according to functions and specifications. Included are powersupply charts in which all factors are tabulated for easy checking. Models of 17 general types are represented by photographs, charts and diagrams. 16 pages. NJE Corp., 20 Boright Ave., Kenilworth,

Circle 637 on Page 19

Thermoplastic Materials

Describes nine widely used thermoplastic materials. Each data sheet contains a brief description of the subject plastic and its typical uses, as well as specifications covering its physical, electrical, and chemical resistance characteristics. Sizes, forms, and colors in which the material can be furnished are shown. 26 pages. Conneaut Rubber & Plastics Co., Commerce Street, Conneaut, Ohio.

Circle 638 on Page 19

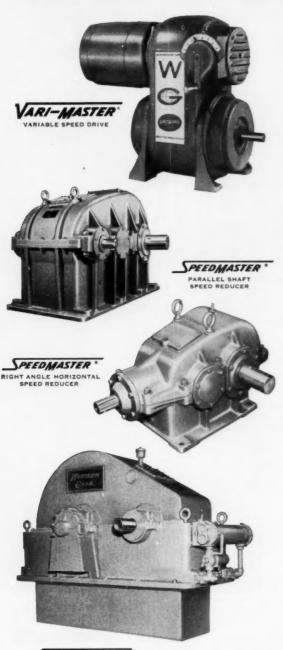
Pressure Gages

Reviews pressure gages with 3 and 5-in. dial sizes which maintain accuracy under conditions of overload pressure, vibration, shock, or line pulsation in various applications. Two 3-in. dial models and three 5-in. dial units are described and illustrated. Pressure range, figure intervals, graduations, connections, dimensions, and specifications are given for each gage. Bulletin 280, 4 pages. American-Standard Controls Div., Rochester Instrument Plant, 100 Rockwood St., Rochester 10, N. Y.

Circle 639 on Page 19



POWER TRANSMISSION REQUIREMENTS?



Just name them!

Western Gear Corporation's line of catalog products in the power transmission field is second to none in quality and reliability.

Three great names fill out the Western Gear line... StraitLine®, SpeedMaster® and Vari-Master®. They have earned a first-rate reputation in all industries using power transmission equipment by providing users and manufacturers these guarantees!

- precision manufacture under uncompromising quality controls
- · long life and reliable operation
- · easy maintenance
- · standardization of parts and high interchangeability

Whatever your power transmission requirements might be, Western Gear can supply them from stock or engineer them to your exact specifications. Want to know more? Use the coupon below or phone. And always remember...



on the long run . . . QUALITY COSTS YOU LESS!

	R CORPORATION • INDUSTRIAL PRODUCTS DIVISION Belmont, California—LYtel 3-7611
☐ Strai ☐ Strai ☐ Spec	send catalogs checked below: tLine Speed Reducers Bulletin 5816 tLine Gearmotors Bulletin 5806 dMaster Parallel Shaft Bulletin dMaster High Speed Bulletin Master Variable Speed Bulletin 6107
NAME	4
COMPANY	TITLE
	STATE

O. HOW THIN CAN METAL TUBING WALLS BE?



It's a fact . . . fine seamless tubing with wall thicknesses as ultra-thin as 0.0005 inches! This is precision tubing drawn to any specified O.D. from 0.010" to 0.375" within tolerances of ± 0.00005 inches.

Techniques for redrawing tubing so thin and within such close tolerances were developed in response to many requests for lightweight tubing with the properties of the many common metals and alloys. Accordingly, ultrathin tubing is available in 304, 310, 316, 321 and 347 stainless steels, Monel, Inconel, Nichrome V, Tophet A, nickel, copper, beryllium copper and glass-sealing alloys.

Ultra-thin tubing is available cleanly cut to any specified length up to six inches. And speaking of light weight—500 feet of ultra-thin 304 SS tubing with an O.D. of 0.375" and a wall thickness of 0.0005" weighs only one pound! Rigid quality control assures you that every bit of ultra-thin tubing falls within the close tolerances.

If you need fine precision tubing with all the inherent properties of a particular metal or alloy listed above and must have the added advantage of light weight, investigate UNIFORM ultra-thin tubing by phoning or wiring the numbers below. Ask, too, about UNIFORM's proved abilities for fabricating tubular parts to exacting specifications. UNIFORM specializes in craftsmanship and fast delivery for fine tubing in most alloys and precious metals.



HELPFUL LITERATURE

Miniature Valves

Describes new series of miniature twoway valves that have been designed specifically for high capacity in a small envelope size. They are available in a wide choice of operators, are simple in design, and have bubble-tight shutoffs. Bulletin 91054, 2 pages. Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio.

Circle 640 on Page 19

Armored Cable

Contains complete listing of fittings and accessories for interlocked armored cable. Connectors accommodate from $\frac{5}{8}$ to 4-in. diam cable of watertight and nonwatertight design. Includes description of a new vaporproof fitting for continuous-sheathed armored cable. Folder F11-135, 4 pages. Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.

Circle 641 on Page 19

Analytical Instruments

Contains specifications and operating data on seven instruments for research and production control. Illustrates applications in various fields. Also gives data on accessory equipment. 28 pages. Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle 642 on Page 19

Miniature Pushbuttons

Revised publication includes new forms added to line of industrial, miniature, oiltight pushbuttons. Shows many color combinations and flexibility available in the line. Explains 40 per cent space savings which may be realized in enclosures or panels by the use of the miniature forms. Bulletin GEA-7127A, 12 pages. General Electric Co., Schenectady 5, N. Y. Circle 643 on Page 19

Pressure Tubing

Discusses use of welded steel pressure tubing for boilers, heat exchangers, condensers. Explains basic principles of welded tubing. Form T-201, 4 pages. Rome Mfg. Co. Div., Revere Copper-Brass Inc., P. O. Box 111, Rome, N. Y.

Circle 644 on Page 19

Control Synchro

Illustrates and describes Size 23 control synchros, for 400-cycle operation, manufactured to meet military specifications. Includes dimensional line drawings and comprehensive characteristics chart. Bulletin CS-4-23-2, 2 pages. Vernitron Corp., 125 Old Country Rd., Carle Place, L. I., N. Y.

Circle 645 on Page 19

Digital Instruments

Gives details and specifications on digital instruments. Includes dc, ac/dc digital voltmeters, preamplifiers, scanners, and readouts. Catalog 19-92, 4 pages. Kin Tel Div., Cohu Electronics Inc., 5725 Kearny Villa Rd., San Diego 12, Calif.

Circle 646 on Page 19

Cuts Assembly Time



Here's fast Clamping Power for your Product . . .



Band is slipped over hose, duct or fitting — then through housing. A downward snap of the swivel screw locks clamp in position for screwdriver tightening. Application is easy, fast, positive.

Wide Adjustment Range for all Applications . . .



Twelve wide adjustment sizes cover diameters $\frac{1}{2}$ to $12\frac{1}{2}$. Select just one size to replace the many different sizes you are now using Snaplock can be used over and over again—rugged construction is fortified by 18-8 stainless steel in band and housing

Typical uses for Snaplock are dust and filter bag connections, power tool attachments, sign hanging and a variety of hose, ducting and conduit applications.

FREE - DISCOVER FOR YOURSELFI

Send for a sample Snaplock clamp. And while you're at it, ask for the brochure describing a complete line of clamps for all industrial applications.



IDEAL CORPORATION
427 Liberty Avenue
Brooklyn 7, H. Y.



Circle 331 on Page 19

KEYSTONE POWDER METALLURGY PROGRESS ...

NEW eystone LUBRICANT 3 to 4 TIMES

...the most significant development in self-lubricated bearings over the past 10 years!



QUIETER—no squeal on thrust! Withstands 300°F service in FHP motors! EXCLUSIVELY KEYSTONE!

These striking improvements in standard Keystone C-64 bearing performance are created by new lubricant A-121-5P—the greatest advance in porous bearing lubrication in a decade!

Exclusively a Keystone Carbon Co. development, Formula A-121-5P is the result of research and intensive study of all available petroleum and synthetic base lubricants, in close cooperation with all major oil companies. A-121-5P is obtainable only from Keystone Carbon Company as the impregnant of bearings of Keystone manufacture.

Already in wide use in small appliances, disposers, washing machines and FHP motors, A-121-5P lubricated bearings are delivering 3400 hours of service in applications with previous maximums of 800 hours—at lower noise levels—without sludging or breakdown over 200°F.

Would you like to test your bearings with A-121-5P? Write, on your letterhead; send us your samples—you be the judge!



EFFICIENT · RELIABLE · ECONOMICAL



McCORD MODEL F GREASE LUBRICATOR

Machine tool, press, turbine, hoist, crusher, conveyor, you name it . . . if it requires greasing, automate with McCord's Model F Grease Lubricator. You'll cut labor costs, prevent work stoppages, minimize maintenance and repairs, reduce lubricant consumption.

Yes, McCord's Model F is fully automatic and features individually controlled feed that positively, accurately delivers the right quantity of grease to each individual point . . . regardless of grease weight, pressures or coldest weather. You can count on it, because McCord Grease Lubricator design and construction is the result of more than 30 years of field experience.

Available with rotary drive, 22.5:1 or 45:1, and ratchet drive, 1.5:1 or 2.5:1. Capacities, 4-16 quarts.

For resistance to cold flow under static

or dynamic loads; low moisture absorp tion: excellent dimensional stability.

For maximum impact strength, good

heat and oxidation resistance, good

Best bearing characteristics and high-

est melting point among the nylons; excellent machinability.

Electrical-grade nylon. Half the mois-

ture absorption, less rigidity, better di-

RELIABLE

FROM STOCK Write for literature and the

creep recovery.

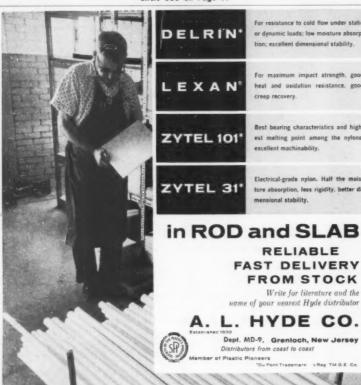
mensional stability.

For full particulars on McCord's Model F, write today to: Advertising Manager-

M'CORD CORPORATION

Lubricator Division • Detroit 11, Michigan

Circle 333 on Page 19



HELPEUL LITERATURE

Quick-Disconnect Couplers

Covers self-sealing Magnum series for hydraulic, pneumatic, and fuel-system applications to 10,000 psi working pressures. Includes charts of performance data, basic design and part-number information, and ordering data. Catalog sheet L-6103-2, 4 pages. Bruning Co., Box 147, Lincoln, Nebr. Circle 647 on Page 19

Terminal Panel Wiring Block

Details specifications on modular terminal panel wiring block, Termi-Blok, designed to replace barrier boards and terminal boards in use in switchboards, control panels, and industrial instrumentation. Folder describes three advantages over traditional terminal and barrier boards which the new connectors have achieved. 4 pages. AMP Inc., Eisenhower Blvd., Harrisburg, Pa.

Circle 648 on Page 19

Polypropylene Material

Gives data on typical properties of No. 1014 general-purpose, injection-molding grade, and also on other grades available. Shows several applications of the material. Includes mold and part design recommendations for polypropylene, 12 pages. Avisun Corp., 1345 Chestnut St., Philadelphia 7, Pa.

Circle 649 on Page 19

DC Amplifier; Power Booster

Describes all-solid-state differential operational amplifier, Model A-2, and power booster Model G-2 for use with the amplifier. Complete electrical and mechanical specifications are presented, together with price information, application schematics, and oscilloscope photographs showing common-mode operation and unity gain waveform reproduction. Bulletins 031, and 032, 6 pages. Ridgefield Instrument Group, P. O. Box 337, Ridgefield, Conn.

Circle 650 on Page 19

Standard Relays

Shows more than 40 standard relays, and gives descriptions, dimensions, technical specifications, and prices for more than 450 variations of the basic relays. Lists power, general and special-purpose, plate-circuit, sensitive, and telephone-type relays. Catalog 100, 8 pages. Potter & Brumfield Div., American Machine & Foundry Co., Princeton, Ind.

Circle 651 on Page 19

Sealed Connectors

Describes and illustrates TI Series hermetic sealed connectors, designed for high temperature, pressure, vacuum-seal, and requirements of nuclear environments. Included are complete specifications of TI plugs and receptacles, and exploded views featuring parts delineation and new potting-boot design. Bulletin TI-3, Physical Sciences Corp., 389 N. Fair Oaks Ave., Pasadena, Calif.

Circle 652 on Page 19

XEROGRAPHY for engineering-drawing reproduction...



...takes the "wait" out of print duplicating... annual savings from \$5,000 to \$200,000 and more!

Xerographic copying equipment is saving hundreds of major industrial firms all over the country up to \$200,000 annually! This clean, fast, dry, electrostatic copying process eliminates costly waiting of highly paid personnel—gives you high quality prints on ordinary paper, in minutes! There's no capital investment; equipment is available at modest monthly rentals.

For high-quality offset paper masters:



Model 1218 copying equipment prepares sharp, inexpensive paper masters from original drawings of A to D size. Larger drawings are perfectly reduced to 12"x 18" masters, from which multiple prints are run off in seconds!

Volume reproduction from original drawings or roll microfilm: Sharp, dry,



duce or copy size-for-size from original drawings or roll microfilm (16 or 35mm).

Reproduction from card-mounted microfilm: The Copyflo 24C and the exciting new 1824 Printer automatically produce dry, positive prints on ordinary paper, veelum, or offset paper masters from 35mm card-mounted microfilm! The Copyflo 24C



produces ready-to-use prints, up to 24"x36", at the rate of 20 linear feet a minute. The new, low cost 1824 Printer, for small volume or large, decentralized users, produces prints from 8½"x 11" to 18"x24"!

Get all the Facts! Write XEROX COR-PORATION (formerly Haloid Xerox Inc.), 61-261X Haloid St., Rochester 3, N. Y.



XEROX



NEW ERIE SOLID STATE 500T BI-DIRECTIONAL CONTROL COUNTER

This is a rugged high-speed control counter with bi-directional capabilities for digital closed loop control. It offers for the first time anti-coincidence circuits for random add/subtract inputs, a digital-to-analog converter and an excess error alarm. The instrument has true modular construction in which individual circuit boards are readily inserted from the front for functional versatility and ease of maintenance. In-line NIXIE readout can be supplied when required.

The unique anti-coincidence circuit used prevents interference between add and subtract pulses arriving simultaneously. This provides absolute accuracy as opposed to conventional anti-coincidence circuits. The analog output is proportional in both magnitude and polarity to the algebraic sum of the add and subtract inputs. The readout indicates the instantaneous algebraic sum.

For example, where the 500T is used for control of motor speeds, the pulses arrive at both the add and subtract inputs at exactly the same rate when the controlled motor is running at the desired speed. Any speed change develops an analog output to a servo system which returns the motor to the proper speed. The same basic process would apply to the mixing of liquids or chemicals.

Applications for the 500T are virtually unlimited since it provides digital control of such parameters as flow, speed, position, and many others. An industrial case is available for applications in rugged environments.







Industrial Model

Complete technical information available on request.



ERIE PACIFIC, DIVISION OF
ERIE RESISTOR CORPORATION
12932 S. Weber Way, Hawthorne, California

Synchronous Motors

Covers low-speed synchronous motors, from 20 to 10,000 hp and 72 to 450 rpm. Construction, modifications, basic considerations, and application-data chart giving typical torque requirements for normal applications are included. Booklet 502, 12 pages. Ideal Electric & Mfg. Co., Dept. 134, Mansfield, Ohio.

Circle 653 on Page 19

Compressed-Air Filter

TR filter removes condensed moisture, oil, and pipe scale from compressed-air lines in a two-stage cleaning cycle. Bulletin gives applications, sizes, specifications, and prices. Bulletin 118, 4 pages. R. P. Adams Co. Inc., 444 E. Park Drive, Buffalo 17, N. Y.

Circle 654 on Page 19

Adjustment Potentiometers

Summarizes information on 20 basic models of adjustment potentiometers, including resistances, terminal types, power ratings, operating temperatures, dimensions, and prices. Includes information on six new models. Summary Brochure 7, 4 pages. Trimpot Div., Bourns Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle 655 on Page 19

Shaft-Position Encoder

Model 212, 11-digit, photoelectric shaftposition encoder converts angular shaft displacement into electrical signals for digital readout. Bulletin illustrates and gives detailed electrical and mechanical specifications. Bulletin 041, 4 pages. A R & T Electronics Inc., P. O. Box 627, Little Rock, Ark.

Circle 656 on Page 19

Selenium Rectifiers

Describes selenium rectifiers covering ranges from microamperes to kiloamperes and voltages from millivolts to kilovolts. Includes high-voltage cartridges, hermetically sealed rectifiers, selenium diodes, are suppressors, and contact protectors. Bulletin 101, 8 pages. Edal Industries Inc., 4 Short Beach Rd., East Haven, Conn.

Circle 657 on Page 19

Electronic Timers

Announces new electronic-timing devices which include time-delay relays, electronic timers, pulse generators, and flashers. 4 pages. Electronic Timer Div., Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 658 on Page 19

AC Capacitors

Features complete listings of expanded air conditioner and refrigeration lines of motor-run, motor-start ac capacitors. Information covering capacities and physical dimensions is shown for all types, and section of engineering data is included. Catalog MS61-10, 16 pages. Aerovox Corp., New Bedford, Mass.

Circle 659 on Page 19



Norgren Lubricators end uncertainty of "blindfold" lubrication of air tools

Over-lubrication of air tools causes oily, dirty tools and hands. Under-lubrication means costly excessive wear. To get lubrication that is just exactly right requires something better than trial and error, "blindfolded" methods of lubricator adjustment. That is why all Norgren Lubricators have visible oil feed.

Visual adjustment results in positive lubrication Norgren Oil-Fog and Micro-Fog Lubricators have sightfeed glasses which provide full visibility of oil flow. You can tell at a glance that oil is actually being metered into the air stream.

The exact rate of oil feed is shown by the drops of oil passing through the sight-feed glass. The rate of oil feed can be easily and accurately adjusted. Contrast this with the disassembly and trial-and-error guesswork adjustment required with wick-type lubricators!

The Norgren Oil-Fog Lubricator has proved itself in hundreds of thousands of installations throughout the world for over 30 years. Today, it is still the best low-cost, positive-action lubricator on the market.

The Norgren Micro-Fog Lubricator offers many additional advantages: More exact metering of oil feed; operation over a wider range of air flows; a finely divided fog of oil with little or no precipitation along the air-line; adaptation to multi-tool, or multi-cylinder lubrication.

Your Norgren Representative will advise you on your application and will give you complete information about Norgren Lubricators. Look him up in your telephone directory—or write factory for Catolog No. 1000.

FOUNDED IN 1925

C. A. NORGREN CO.

3442 SOUTH ELATI STREET, ENGLEWOOD, COLORADO





New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Hollow-Shaft Differentials

have backlash of 8 min or less

Precision hollow-shaft differentials are available for use in computers and control instruments where mounting requirements are restricted. Clearance circles down to 1 in. or less are provided by the units, minimizing installation space. Other features include central built-in clamping, backlash of 8 min or less, and break-away torque of 0.3 oz-in. or less. Construction is stainless steel except where aluminum spider gears are specified. Each



unit employs miniature ball bearings which conform to ABEC-7 tolerance requirements. Differentials are available with 0.1248, 0.1873, and 0.2498-in. bores in narrow and standard width (miter) designs. They can be supplied with end gears made from flat blanks parallel within 0.0002 in. Wide range of pitch and number of teeth for end gears is available. Gears are mounted on differentials with true lock serration. Instru-Lec Corp., 520 Homestead Ave., Mt. Vernon, N. Y.

Circle 660 on Page 19

Miniature Blower

operates at 3600 rpm

Miniature axial blower delivers 15 cfm at 0.2 in. water, operating at 3600 rpm from a single-phase, 117-



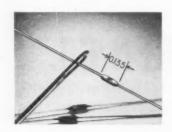
v, 60-cps source. Blower is enclosed in a precision-cast aluminum housing. Continuous-operation life is rated in excess of 2500 hr. Unit meets appropriate MIL specs. Mounting flange dimensions are 3.44 in. square; bolt holes are spaced 2.75 in. apart. Over-all length is 3.25 in.; weight, 12 oz. Globe Industries Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 661 on Page 19

Miniature Resistors

rated ½ w, 250 v in temperatures to 100 C

CE- $^{1}/_{8}$ resistors, 0.135 in. long and 0.050 in. diam, show no loss in electrical performance characteristics. They are rated $^{1}/_{8}$ w, 250 v in an ambient temperature of 100 C, derated to zero load at 150 C. Units cover the range from 25 to 110,000 ohms at either ± 1 or ± 2 per cent tolerance. Leads of soft, tinned copper are 1 in. long and 0.016 in. diam. Noble-metal film resists oxidation, moisture, high humidity, low temperatures, and temperature cycling between -55



and +150 C. Temperature coefficient is either 50 or 100 ppm per deg C. American Components Inc., 8th Ave. and Harry St., Conshohocken, Pa.

Circle 662 on Page 19

Self-Aligning Bearing

is one-piece unit in aluminum housing

Lube-Align bearing consists of a one-piece, integrally cast, spherical, self-lubricating bronze bearing nested in an aluminum housing. Bearing is self-aligning. Design eliminates the necessity of oil cups or grease fittings. Unit features total contact support for the spherical, self-aligning bearing, making it possible to use miniature sized units with smaller OD shafting to carry



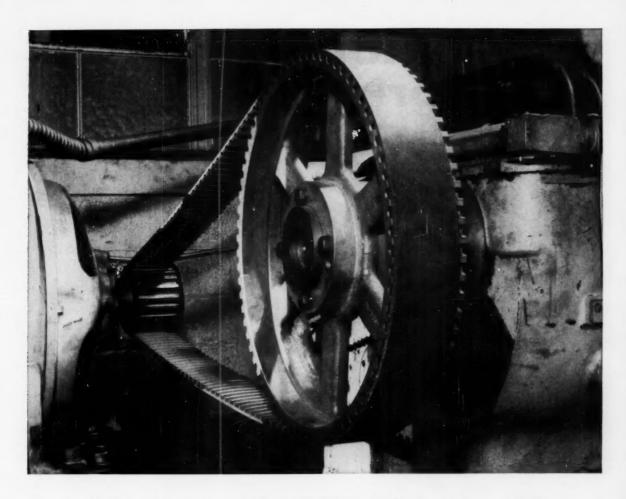
increased loads. **Bronze Bearings** Inc., 3553 W. Addison St., Chicago 18, Ill.

Circle 663 on Page 19

Wire Markers

permit writing of own codes or legends

Self - laminating, write-on wire markers are used where requirements call for small quantities of markers of many different special legends. Each self-adhering marker is partly a write-on marker and partly transparent as a self-contained lamination extension. When marker is applied around wire, re-



Here's how WOOD'S helps you with PROBLEM-SOLVING, POSITIVE ACTION

Five, easily under stood charts, developed by Wood's, permit proper drive design with almost no calculations. WRITE FOR BULLETIN 21103.



Wood's has the drive, the positive action Timing Belt Drive . . . PLUS THE EXPERIENCE it takes to give positive, workable solutions to your power transmission problems. Wood's Timing Belt Drives provide instantaneous, slip-free response . . . full power transmission. They require no lubrication, no motor bases, no tensioning devices. Belt matching is eliminated. And, their speed range is exceptional . . . from 0 to 16,000 fpm. Load capacities range up to 600 hp and above. Belts are unusually strong, but they are thin and flex readily, eliminating heat build-up, maintaining high operating efficiency. When you want positive action, investigate Wood's Timing Belt Drives. You'll find outstanding solutions to a wide variety of drive problems.



T. B. WOOD'S SONS COMPANY

CHAMBERSBURG, PENNSYLVANIA

ATLANTA . CAMBRIDGE . CHICAGO . CLEVELAND . DALLAS

TD/161

September 14, 1961

Circle 338 on Page 19

251



NOW AVAILABLE -**NEW SIZE H-44** electro-magnetic DISC BRAKES

Prompt Shipment

Torque-3 lb-ft, max. Weight-51/2 lb

> Exclusive Stearnetic unitized construction, and "Visi-Wear-Indicator"

MORE TORQUE PER POUND... MORE TORQUE PER CUBIC INCH!

THE NEW STEARNS "H-44's" are spring set-solenoid released disc brakes that mount on NEMA "C" flanges of "40 frame" fractional hp electric motors . . . provide fast, smooth, quiet stops-"failsafe" operation . . . combine higher torque with minimum size and weight.

THE NEW STEARNS "H-44's" are available for either AC or DC . . . in Standard, or Dustight-Waterproof enclosures . . . operate horizontally or vertically . . . are also available with brackets for floor mounting.

Specify THE NEW STEARNS "H-44's" with complete confidence—they have been fully life-tested, and Installation-Proved for long, trouble-free, dependable operational life with a minimum of maintenance.

Request Stearns New Product Preview 1-61-B

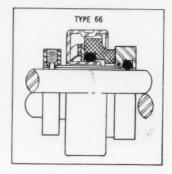


SINCE 1917-THE CHOICE OF LEADING MOTOR AND

wraps around itself, causing it to laminate permanently over the written code. Westline E-Z Code Div., Western Lithograph Co., 689 E. 2nd St., Los Angeles 54, Calif. Circle 664 on Page 19

incorporate unitized construction

Three types of seals in new line contain both stationary seal face and positive-drive mating ring assembled as one unit. Seals can be disassembled and seal faces reconditioned, resulting in long seal life and ease of service. Unitized construction is useful in applications



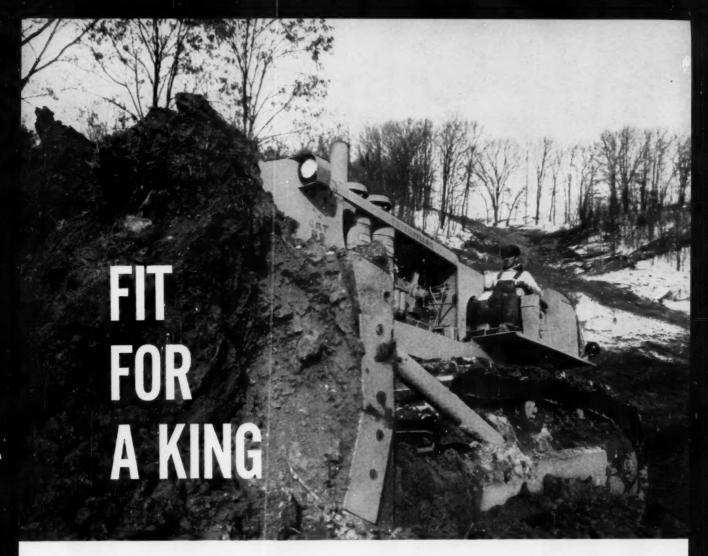
such as home appliances, domestic pumps, industrial pumps, speed reducers, gear motors, machine tools, construction equipment, and aircraft. Type 66 (shown) is available for pressures to 250 psi, and accepts speeds to 10,000 fpm and temperatures from -65 to 400 F. Types 46 and 48 have pressures to 10 psi, speeds to 3500 fpm, and temperatures from -20 to +250 F. Gits Bros. Mfg. Co., 1866 S. Kilbourn Ave., Chicago 23, Ill.

Circle 665 on Page 19

Germanium Power Transistors

in TO-36 Case have wide range of applications

Eight germanium power transistors have junction temperature ratings of 110 C and maximum power dissipation ratings of 170 w. Units are packaged in the TO-36 (doorknob) case, for which previous maximum ratings were 95 C and 88 w. Transistors are capable of 30 w power dissipation at 95 C case temperature.

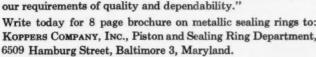


Caterpillar selects Koppers piston and sealing rings for use in the world's largest single engine crawler tractor.

A brute of a tractor for brute force jobs, Caterpillar's D9 Series E Tractor applies a 335 HP engine which combines the versatility and economy of diesel power with the power boosting efficiency of a turbocharger. Traditional Caterpillar durability is built into every part. And in the power shift transmission sealing rings, chrome plated malleable iron compression rings, crankshaft seals, and steering control seals, that durability spells K-O-P-P-E-R-S.

Says Caterpillar: "The D9 Tractor is ruggedly built for long life under the most severe operating conditions. In addition, special attention has been given to insure the production of a power plant that is easy and economical to operate and maintain. On all these counts, the Koppers rings and seals we have selected meet our requirements of quality and dependability."

Write today for 8 page brochure on metallic sealing rings to: KOPPERS COMPANY, INC., Piston and Sealing Ring Department, 6509 Hamburg Street, Baltimore 3, Maryland.





PISTON & SEALING RINGS

Engineered Products Sold with Service

Circle 340 on Page 19



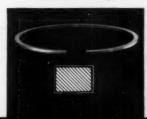
CRANKSHAFT SEALS: Application of a conformable step seal ring (specially designed for Caterpillar) establishes a permanent crankshaft permanent crankshaft eal, reliable for the life of

COMPRESSION RINGS: Dependable performance at the most critical point in the combustion chamber is assured by chrome plated malleable iron rings.



RINGS: Specially designed metallic sealing rings trans-mit fluid power to the rotor and actuate the clutches of Caterpillar's dramatic new power shift transmission.

STEERING CONTROL SEALS: Caterpillar's new design steering control requires a rotating, high pressure seal. Piston ring type seals estab-lish simplicity, reliability.





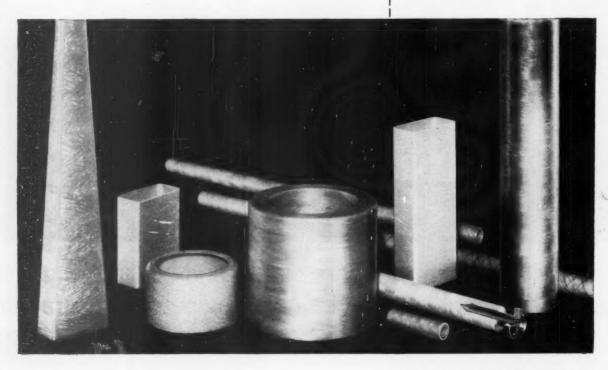
SPAULDING GFW-60*

*Glass filament wound epoxy tubing gives industry a new high burst strength material

Spaulding GFW-60 is designed to provide industry with a material of extremely high burst strengths for such applications as circuit breaker arc interruption chambers, high-voltage fuse tubes, switch gear and similar type components. It can be furnished with fibre liners, metal inserts, or with conductive layers.

Its ratio of burst strength to axial tensile strength can be varied to fit specific applications.

It is available in a variety of circular sizes and lengths, and with special shapes.



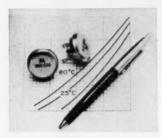
PROFILE OF CHARACTERISTICS

As with All of its Products for Industry, Spaulding Offers Complete Value Analysis and Fabricating Services for Your Application of GFW-60. Contact Spaulding for Details.

SPAULDING GFW-60 (1" x 11/4" size)					
Water Absorption	%	.05			
Grease Burst	psi	22,500			
Tensile Strength	psi	8,250			
Compression Strength Axially Radially	psi As Received As Received	19,300 920			
Dielectric Strength V/M Perpendicular	Short Time	401+			

SPAULDING FIBRE COMPANY, INC.

3 3 9 WHEELER STREET, TONAWANDA, NEW YORK



They are available under type numbers 2N2075 to 2N2082. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 666 on Page 19

Silicone Resins

have metal fillers

New silicone resins, designated Epocast H-1759 systems, are basically rubberlike in character, due to silicone-resin structure. Materials can be used at both very low and very high temperatures to fulfill design requirements of aircraft, electronics, missile, construction, nuclear radiation shielding and consumer products. Among the products available are lead, bronze, steel, copper, and aluminum-filled silicones. Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Calif.

Circle 667 on Page 19

Ball-Bearing Screw Assemblies

provide high load-carrying capacities

New ball-bearing screw assemblies limit the travel of the nut at predetermined positions, with continuing rotation of the ball-bearing screw. Freewheeling action was accomplished previously by providing pin stops in the screw at each end of the desired nut travel, and



a simple torque limiter secured to the nut. With new design, three washers, two steel and one nylon, replace each stop-pin and eliminate danger of breakage. Assemblies provide high load-carrying capacities. Mechanical efficiencies range from (Please turn to Page 258)



Dynapar is the electronic subsidiary of The Louis Allis Co. We make a full line of transistorized digital devices for high-speed counting, measuring, and control. Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."



Draw Indicators



Process Controllers



DYNAPAR CORP., 459 E. STEWART ST., MILWAUKEE 1, WIS. A subsidiary of The Louis Allis Co.

0 REMOTE INDICATOR



New product news from Louis Allis

NOW...Louis Ailis offers DYNAPAR* Digital Control Systems!

Louis Allis can supply accurate digital controls designed to <u>industrial</u> standards for a wide variety of continuous process lines

For any production process, Louis Allis can furnish not only motors, drives, and controls, but also digital monitoring equipment to provide visual readout and process control signals.

The answer is DYNAPAR* Digital Control — a highly accurate digital logic system that can count, measure, totalize, indicate, time, or control depending on the requirements of the application. Digital systems are ideally suited for high speed counting — accurate measurement of speed and draw — automatic cutting-to-length — automatic positioning — and many other applications.

Dynapar's digital devices utilize precise pulses, and eliminate the drift inaccuracy inherent in magnitude-measuring analog systems. There's no need for constant calibration or adjustment. Pulses are reliably provided by rugged ROTO-PULSERS, highly stable sensing and pulse generating devices — visual indication is obtained by easily-read luminous direct numerical readouts. Control functions are accomplished by a variety of special devices tailored to specific operations. All DYNAPAR equipment features the most modern solid-state transistorized circuitry to provide long-life operation without maintenance.

Investigate to see how Louis Allis-Dynapar equipment can increase production and cut waste by automating *your* process. Call your local Louis Allis District Office, or write to The Louis Allis Co., 459 E. Stewart St., Milwaukee 1, Wis.

*Dynapar Corporation is the electronic subsidiary of The Louis Allis Co.



MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

4) RECORDING WEIGHT DATA

5) CONTROLLING PROCESSING EQUIPMENT

Other con function as requir

This weight-sensing principle may solve your design problem

If your product involves automatic control — processes, quality or costs — the Exact Weight principle of weighing or measurement of force may help solve your problem.

This precision weighing system, using photodiodes arranged to read deflections of a light beam, automatically supplies electrical output signals for a variety of sorting and control devices. Today, the Exact Weight principle is being used for positive control of basic operative functions in many types of automated machines including packaging, metalworking, textiles and plastics weighfeeders.

Send us your application requirements — or any weighing problem. Our engineers will gladly cooperate with you and make recommendations for the most economical solution.

NEW REFERENCE MANUAL

Here is a source of helpful design ideas showing various applications of weight sensing used in control functions. It is available free. Write for your copy today.





THE EXACT WEIGHT SCALE CO.

925 W. FIFTH AVE., COLUMBUS 8, OHIO In Canada: 5 Six Points Road, Toronto 18, Ont.

NEW PARTS AND MATERIALS

(Continued from Page 255)

90 to 95 per cent, and there is no tendency for the units to creep under load. Actuators are suited for overload protection or for accurate positioning. Also, they can be used as holding devices, forward-stopreverse systems, or stepless-control units. Saginaw Steering Gear Div., General Motors Corp., Saginaw, Mich.

Circle 668 on Page 19

AC Gear Motors

in hysteresis-synchronous and low-slip induction units

Fractional-horsepower ac gear motors are available in hysteresis-synchronous and low-slip induction types. Induction type provides a torque range to 300 oz-in. at 1 rpm. Hysteresis-synchronous type is available in a frame diameter of 2



in. and induction type is available in 1¾ or 2-in. diam frames. Lengths of the units vary from 3¼ to 6 in., depending on application specification. Ashland Electric Products Inc., 32-02 Queens Blvd., Long Island City 1, N. Y.

Circle 669 on Page 19

Flow-Divider Valve

with locked stops to provide 10 calibrated rates to 60 gpm

Model 131089 large capacity, adjustable flow-divider valve, with lever-operated flow control, simplifies control of hydraulic systems requiring a variable rate of fluid flow from one fixed-displacement pump. Lever-controlled orifice can be adjusted to provide optimum rate of flow to meet specific conditions. Positively locked stops provide 10 calibrated rates up to 60 gpm in addition to shut-off position. Fluid in excess of the amount delivered to priority port can be used to op-

Some Ideas



for your file of practical information on drafting and reproduction

KEUFFEL & ESSER CO.

The stone tablet and chisel were pretty widely used writing and drawing instruments in their day.

But they don't command much of a following any longer. Like so many tools of the past, they gave way to better methods of portraying information. Some of these methods occurred by accident, some were developed by experts to serve specialized needs. Three good examples of the latter are described here.

A Couple of "Better" Pencils

When polyester drafting film first came into use, it was found that standard graphite pencils with clay binders, while fine for paper, smudged too readily on film.

So a new kind of pencil was needed—and developed. It was called the Duralar. With both binder and color agent made entirely of plastic, Duralar deposited a black, dense line on film, which could neither be smudged nor washed away.



But since washability is not the touchstone of every drafting operation, K&E went a step further. Result—the Ruwe pencil. Having all the "fine feel" and erasibility of graphite, on both film and cloth, the Ruwe deposits a blacker, denser line than graphite, with the smudge resistance the old graphite pencil could not provide.

Here's why: the Ruwe pencil is graphite, but with a plastic binder instead of clay. Color coded in five degrees of hardness from 2S to 6S, Ruwe is available in wood pencils and leads. More good news is that Ruwe is now available in 2S and 3S hardnesses for fine-line automatic pencils as well. The lead is just .036" in thickness—ideal for free-hand lettering.

It's interesting to note, that since the introduction of Ruwe, other plastic-graphite pencils have been placed on the market. If you're interested in testing the original we'll send free Ruwe pencils to you — just send the coupon.

Now You See 'em... Now You Don't

For engineering drawings, or freehand sketches, K&E GUIDE LINE^{T.M.} tracing papers, cloths and films make light work for you. — by making light work for you. The light blue cross-section lines are visible to the eye, but will not reproduce on your diazos or blueprints. Other companies make similar products but here's the important K&E contribution: GUIDE LINE is now available in the widest variety of

drafting media ever. Specifically: Alban-Ene® and Crystalene® 100% rag stock tracing papers, Phoenix® water-resistant tracing cloth and Herculene® polyester base drafting film. So whichever sheet you use, odds are it's available in Guide Line first.

We especially recommend GUIDE LINE products for accurately guiding freehand work such as plant layouts, organization charts, electrical diagrams, etc. Your freehand work actually will look more like a finished detail than a sketch. And confidential notes will drop out too, if written or typed in special colors.

Available in a wide variety of grid sizes, GUIDE LINE comes in rolls or pads on ALBANENE and CRYSTALENE, in rolls on PHOENIX and HERCULENE, and can be supplied with your own title block or special heading.

Send for some free samples and the GUIDE LINE brochure.

Through The Looking Glass

No more "Alice in Wonderland" wandering about when you want to locate the graph sheet you need for a specific job. Reason — K&E graph sheets now are packaged with a new "looking glass" — A timesaving visual package. This unique pack-

age has a window in the front so you can see the sheet inside. This is a boon, especially if you use a wide variety of graph sheets. Apart from the packaging, we've done a few other things to make graphsheet selection easy and infallible.

Every user of graph paper puts it to a different task. So we have put together a complete line of graph papers, one or more of which will almost certainly meet your particular requirements. As a matter of fact, odds are 1000 to 1 that we already make and sell the sheet you require. In the event that we don't, we'll work with you to create it.

And we bend over backwards to make sure every sheet with the K&E symbol more than does its job. To insure accuracy of performance, every K&E graph sheet ever made was printed from precision-engraved plates by the letterpress process. The paper used—translucent or opaque—has at *least* 50% rag content—100% in some cases. And before any of it ever gets to the printer, it undergoes extensive examination in our quality control labs.

There is a lot more we could tell you about K&E graph sheets. We have prepared a selection guide for your use. If you'd like to have one, it's free, along with some sample sheets in the new visual package.



12,300 variables at a glance. Here's a typical stock market chart used to study relative market action. Center line is market behavior of 540 stocks over 20-year period. Two basic stock groups of 25 and 50 individual stocks, averaged, are plotted against market (figured at zero per cent). Resultant chart shows all-important slope of curve which —far more than gross increases — tells the story of the stocks' vitality. No list of statistics, no matter how exhaustive, could give the relative interactions shown here. This picture is possible only with a graph.

KE	UFFEL & ESSER CO., Dept. MD-9, Hoboken, N. J	J.
Plea	ase send me free:	
	Ruwe Pencils Guide LineT.M. Brochure and Sar	mples
	Graph-paper Selection Guide and Samples	
Nan	ne & Title	
Com	npany & Address	



Morganite PY7 Seals provide high reliability in this missile application where premium performance is essential due to severe environmental conditions. Combustion gases at 900°F are on one side, oil at low temperature on the other. Speed is 3600 R.P.M., face load 20 lbs. and mating surface is stainless steel.

Specify Morganite for all seal requirements. Ask Morganite engineers for a recommendation on your specific applications. Morganite seals assure longer life in the presence of grease, searching liquids, corrosives, high pressures and high temperatures. Call or write for complete data, today — please address inquiries on company letterhead.

FOR OVER HALF A CENTURY.



Manufacturers of Fine Carbon Graphite Products Including Mechanical Carbons, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts — Distributors of 99.7% Pure Al₂0₃ Tubes, Crucibles and Crusilite Electric Heating Elements.

3314 48th Avenue, Long Island City 1, New York

In Canada: Morganite Canada Ltd., Toronto



erate another completely independent system at high or lower pressure with no effect on the controlled system. Unit handles all standard mineral-type hydraulic fluids at temperatures to 250 F. Hydraulic - Electronic Div., Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio.

Circle 670 on Page 19

Cap Screws

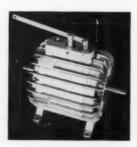
in lengths from 6 to 30 in.

Heavy-duty, high-tensile-strength cap screws are available in diameters from 9/16 to 3½ in. and lengths from 6 to 30 in. Average minimum tensile strength for Supertanium cap screws is 160,000 psi. Corrosion-resistant finish permits easy removal of the cap screws for machine maintenance. Premier Industrial Corp., 4415 Euclid Ave., Cleveland 3, Ohio.

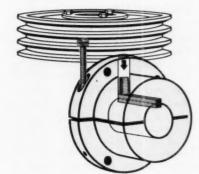
Adjustable-Speed Drive

for applications with power requirements to 5 hp

Tru-Speed hydraulic adjustablespeed drive unit provides an infinitely adjustable output-shaft speed from a constant input speed. Output speed is controlled throughout entire range by a control valve that regulates the flow of oil in the power and speed-transmitting component of the hydraulic unit. Initial



"AND THEN **KEY** LOOSE..."



"Well, the key broke a window-it could have killed someone. A shaft was scored . . . the loss of drive power resulted in a loss of material . . . over \$1,000 . . . we had to postpone deliveries 4 days." Frankly, this plant manager had it rough . . . though it could have been a lot worse, too. But he could have avoided the trouble completely by using Worthington sheaves that have the Two Golden Screws.

The Golden Clamp Screw at the left is an exclusive Worthington feature that locates and locks the hub securely on the shaft, permitting you to tighten the set screw without distorting the hub. And note that the two-piece hub-and-rim design simplifies installation. You install one piece at a time-or change sheaves without disturbing the hub or affecting the alignment.

The Golden Screw on the right is the set screw that turns down to lock the key securely in place. It prevents potentially damaging key drift. There's no extra cost for the set screw but it is worth its weight in gold for the safety it provides.

These Worthington hubs are standard in three







major Worthington drive systems: the new, money-saving, more compact Multi-Wedge Drive; the standard Multi-V Drive and the Positive Drive. Ask for one or more of the "how-to-figure-it" design manuals shown here. Your local Worthington distributor stocks these products. He's listed in the Yellow Pages. Or write Worthington Corporation, Section 79-42, Oil City, Pennsylvania.



PRODUCTS THAT WORK FOR YOUR PROFIT



CUT PUMP COSTS

USE AURORA CENTRI-PAC PUMPS

CAPACITIES TO 400 GPM / HEADS TO 150 FEET

AVAILABLE IN A VARIETY OF PACKAGED SIZES

AIR CONDITIONING EQUIPMENT / CIRCULATING SERVICES / GENERAL SERVICES

- LOWER IN COST... made possible by standardization of most popular sizes packaged and stocked for immediate off-the-shelf shipment.
- EXTREMELY COMPACT...close-coupled design saves valuable space and is more easily installed.
- HIGHLY EFFICIENT...low horsepower requirement means less initial cost and lower operating expense.
- EASILY MAINTAINED... pump can be completely disassembled for inspection and repair without disturbing the piping.
- OUALITY CONSTRUCTION... bronze fitted, mechanical seals, dripproof NEMA rated motor with stainless steel shaft and built-in overload protection, and cast bronze impeller keyed and locked in position.
- SMOOTH, QUIET OPERATION...low NPSH meets critical suction conditions.

You may also select from a complete line of horizontal or vertical mounted pumps and flexible-coupled pedestal-mounted pumps engineered to your specific requirements.

WRITE FOR BULLETIN 117 PKG



AURORA, ILLINOIS

model is suitable for applications with power requirements to 5 hp. Unit has stationary aluminum housing with integral foot-type mounting brackets. Log-Master Services Inc., 402 E. Randolph, Enid, Okla. Circle 672 on Page 19

Swivel, Rigid Casters

in wheel diameters from 4 to 12-in.

Floor-protective, high-capacity swivel and rigid casters are equipped with Duralast polyurethane tread wheels. Wheel diameters range from 4 to 12 in. and tread widths from $1\frac{1}{2}$ to 4 in. Wheel capacities range from 500 to 4000 lb each. Wheels outwear ordinary rubber.



Tread material is a synthetic urethane elastomer that resists corrosion and is noiseless, nonmarking, and impervious to oil, brine, and most solvents. Hamilton Caster & Mfg. Co., 1700 Dixie Highway, Hamilton, Ohio.

Circle 673 on Page 19

Electronic Timers

offer time delays to 60 sec

Crystal-case timers are used wherever reduced weight and volume, together with high accuracy and reliability, are important considerations. Microminiature units employ a solid-state, multistage, silicon-transistor timing circuit. Hermetically - sealed timer package weighs 0.8 oz and measures 1.0 x 0.8 x 0.4 in. Accuracy rating is ±10 per cent of nominal time delay. Temperature range is -55 to +125 C. Units resist vibration of 20g to 2000 cps and shock of 100g for 11 millisec. They meet or exceed all applicable requirements of MIL-E-5272B and MIL-E-5400C. Both fixed and adjustable time-delay



At Lamb Electric...Engineers with FHP motor "know-how" solve intricate design problems

At Lamb, every fractional horsepower motor design problem is special. Because the problems are special, Lamb engineers funnel their years of "know-how" into each intricate project. The result: unusual benefits for you.

Fractional horsepower motors from Lamb incorporate the best possible design, flexibility, and production economy.

If you have a special motor problem ... here's what you can expect from Lamb. Into the design goes years of experience in power components for aircraft, domestic and industrial products. Out of the design comes a personalized motor that's dependable, smooth and efficient.

Circle 349 on Page 19

Cost-wise, you're way ahead, because Lamb Motors are mass-produced at the most favorable cost.

Write today for descriptive folder. Or ask to have a District Engineer call and set up a personalized "Motor Conference".

THE LAMB ELECTRIC COMPANY · Kent. Ohio

A Division of American Machine and Metals, Inc.
In Canada: Lamb Electric—Division of Sangamo Company, Ltd.
Leaside, Ontario

Lamb Electric

SPECIAL APPLICATION MOTOR

Divisions of American Machine and Metals, Inc., New York 7, New York TROY LAUNDRY MACHINERY RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC CO. • HUNTER SPRING CO. • GLASER-STEERS CORP.



Eliminate special sizes...fit more accurately!

S. S. White General Purpose "GP" Plastic Protectors are an improved way to protect your products during manufacturing, shipping and storage.

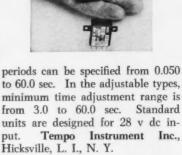
Each GP protector can be used as either a cap or a plug on all machine screw threads, pipe threads, and tubing in a range from 1/4" to 21/4"... with an accurate, engineered fit. GP protectors eliminate special sizes and fit better!

"GP" protectors are made of a special grade of elastic polyethylene that cushions shock and is unaffected by oils, greases, acids and other common solvents. They have a "stayput" fit, yet they are easy to grip for a quick, non-shredding

Start now to put an end to customer complaints about damaged equipment. Use low cost GP protectors!

> WRITE FOR BULLETIN 6104-GP Complete details

Dept. 4P, 10 East 40th Street, New York 16, N.Y.



periods can be specified from 0.050 to 60.0 sec. In the adjustable types, minimum time adjustment range is from 3.0 to 60.0 sec. Standard units are designed for 28 v dc in-

Circle 674 on Page 19

Pressure-Sensitive Nameplates

are available in new materials

Allied - Imperial pressure - sensitive nameplates and decorative trim are heat stamped, embossed, screened, and die-cut in many arrangements. New materials include metallic and clear Mylars, vinyls, aluminum foils, and wood and leather grains. Dept. 761-A, Allied Decals Inc., 20700 Miles Ave., Cleveland 28, Ohio.

Circle 675 on Page 19

Organic Friction Material

controls brakes and clutches at temperatures to 1000 F

Style 160 organic friction material almost completely eliminates fading under high-temperature conditions. With the material, positive control of brakes and clutches is possible at temperatures to 1000 F, under conditions of high loads and fast cycling. Material is particularly suited to severe-duty service. It exhibits an average coefficient of friction of 0.56 at 350 F, 0.62 at 600 F,



PRESSURE BY THE POUND... no matter how thin you slice it!

Do You Have A Bomb In Your Lab?

In the process industry, sampling cylinders are occasionally referred to as bombs. In recent months, this misnomer has been, unhappily, pretty close to the truth. Some military surplus, low carbon steel, two-piece cylinders have found their way into industry and have been used beyond their rather limited capabilities. Unfortunately, several serious accidents have spotlighted this use as a very real safety problem.

Since sampling is such a serious business, we have perfected, for maximum safety, a seamless, onepiece cylinder. This unabashed declaration of excellence has sound



basis in fact — the entire cylinder is formed from a single piece of seamless type 304 stainless steel tube. To quell the qualms of process men, sample contamination is practically nonexistent, and the cylinder resists destruction from most corrosives.

As a further safety guarantee, all standard sampling cylinders are fabricated to meet ICC and other safety regulations. Standard cylinders are available at pressures to 1800 psi (10 ml. to 1 gallon), but higher pressure cylinders can be had on special order.

If you'd like additional information on Hoke cylinders, plus a detailed paper on the various methods of collecting samples from process lines, drop us a line. We'll also include details on special cylinder valves, outage tubes and other cylinder accessories. One trouble with doing something better is that it's hard to stop. This time, we've come up with a new line of pressure regulators. We made them for the technically oriented who have developed high standards and for the penurious purchaser who wants something for (almost) nothing.



One, tagged as the 680 Series, is a highly stable single stage regulator with something for just about everyone. The core of this regulator is its control accuracy of 2% at flows to 2000 SCFH. Two models are available. One delivers 0 to 40 psi and the other 0 to 140 psi and both can handle inlet pressures up to 3000 psi. Use them on any gas compatible with 2024-T4 aluminum alloy, neoprene, polyurethane and Buna-N.

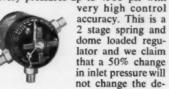
If what we've said sounds good so far, but still won't solve your problems, read on.



We've built a regulator specially for corrosive gases and atmospheres. Available in either all monel or all stainless steel construction, we call it the 640 Series. Spec sheets on this

can be had by marking an "X" below.

If you "X" the next box, you'll get a package of useful information on a special regulator that will handle delivery pressures up to 4500 psi with



livery pressure more than 2%. Operation is simplicity itself. For no particular reason, we call this the 920 Series.

Skeptics should send for all of this information.

'61 PRODUCT PARADE

You'd be surprised at some of the screwball ways our valves have been used (to decided advantage, of course). Hoke distributors are armed to their maxillary third molars with this method madness and will redesign your systems with new Hoke products at the drop of a postcard. Check the PRODUCT PARADE Box.

Hoke's Performance Guarantee - Every Valve Leak-Tested!

HOKE INCORPO	RATED	
91 Piermont Roa	d, Cresskill, N. J.	
Send me complete	information on the Ho	ke products checked below:
☐ 680 Series Regulator	NAME	TITLE
☐ 640 Series Regulator		
☐ 920 Series Regulator	COMPANY	1
☐ '61 Product Parade	ADDRESS	
Sampling Cylinders	*	
Complete Catalog	CITY	STATE

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

SPHERCO BEARINGS



If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.



WRITE FOR BULLETIN 560



Circle 352 on Page 19

NEW PARTS AND MATERIALS

and 0.53 at 1000 F. The rigid, molded material is tan in color, and contains zinc particles. It is manufactured in blocks, facings, and sheets suitable for industrial applications. Johns-Manville, 22 E. 40th St., New York 16, N. Y.

Circle 676 on Page 19

Needle Bearings

in eight new sizes

Eight new sizes of Thin-Shell needle bearings bring the total to 22 sizes with $\frac{9}{8}$ to $1\frac{9}{8}$ -in. bores, including 12 different bore sizes. Bear-



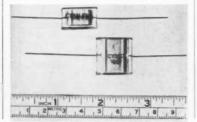
ings feature spherical-end needle rollers in a simplified precision-steel shell. Sizes range from ½ to 1½-in. width, and 9/16 to 111/16-in. OD. All sizes exceed requirements for operation at speeds to 6000 rpm. Kaydon Engineering Corp., Muskegon, Mich.

Circle 677 on Page 19

Glass Capacitors

are suited for airborne and space applications

Addition of two new models, CYFM-20 and CYFM-30, completes a full line of environment-proof glass capacitors. CYFM-20 has capacitance range from 560 to 3300 pf at 500 v and 3600 to 5100 pf at 300 v. Capacitance range of the CYFM-30 is from 3600 to 6200 pf at 500 v and from 6800 to 10,000 pf at 300 v. Capacitors are made of alternate layers of conductor and glass dielectric, fused





BETTER WITH A HEXSEAL*

HEXSEALS are modular external seals. They fit onto switches, potentiometers, circuit breakers and lighted push-buttons.

We also make:

- SEELSKREWS*
- SEELBOLTS*
- SEELRIVITS*
- SEELTHREDS*

SELF-SEALING HARDWARE

APM PRODUCTS MEET
ALL APPLICABLE MIL SPECS.

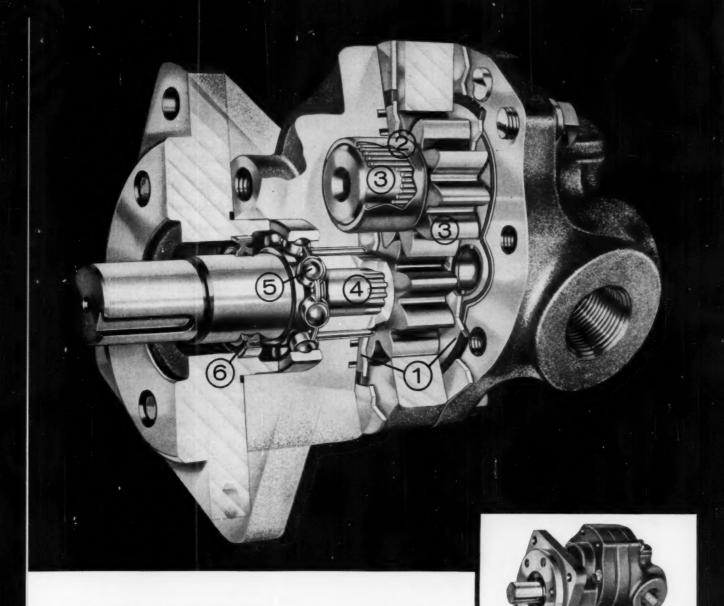
Our list of modular seals is just too long for this ad. Let us send you our Catalog No. 359B.

Write or call:

MISS RIVA SOLINS



41 Honeck Street, Englewood, N. J. LOwell 9-5700



Here's how webster puts new efficiency in hydraulic power

We cut this new JE series pump in half to show you why Webster design tops competition in overall efficiency. Specifically, the JE saves horsepower, slashes operating costs, delivers dependable and trouble-free service.

It's the result of this combination of advanced features....(1) pressure-balanced wear plates for high volumetric efficiency and to prevent clearance changes due to heat; (2) needle bearings for powersaving, anti-friction operation; (3) one piece gear and bearing journal units to assure minimum deflection and proper alignment on both drive and idler assembly; (4) free-floating internal spline drives to eliminate key failures; (5) thrust bearing on drive shaft to absorb compound driving thrusts; (6) double lip seal on drive shaft for added protection against seal failure and dirt.

The Webster JE series pump is a heavy-duty, big power unit built to meet the needs of the mobile industry. It is trim and compact to fit into tight quarters, attaches with a choice of mountings. Your Webster Electric representative has complete specifications and data — or write direct for engineering detailed sheet HY1-1.

JE SERIES PUMPS

Shaft seal: double lip type
Drive: direct, gear or belt
Capacity: 10 sizes — 5 to 40 gpm
Pressures: to 2000 psi
Operating Speeds: to 2400 rpm
Porting: side (std.) end (opt.)
Mounting: SAE Type A (std.)

WEBSTER ELECTRIC

New principle assures

ACCURATE COUNTING

and trouble-free long life



Atcotrol 310 automatic reset **Impulse** Counter

Utilizes an entirely new type impulse motor assuring better accuracy, long life and dependability. Requires a pulse of only 50 milliseconds duration. Standard ranges: 1-40, 2-120, 4-240, 5-480, and 10-960 counts at 500 counts per minute. Cascade arrangements permit higher counts.

Other ATCOTROL Counters



PUSH BUTTON IMPULSE COUNTER - 311

Manual push-to-start button, automatic reset. Five ranges available: 1-40 \pm 0; 2-120 and 4-240 by \pm 1; 5-480 and 10-960 by \pm 2. 10 amps at 115 v a-c. ¼ amp at 115 v, d-c. For batch process control and fluid metering.



AUTOMATIC RESET REVOLUTION COUNTER - 307

Count ranges from 0-12 to 0-240,000 revolutions for use on linear measuring devices, winding machines and batch liquid controls; applications where rotating shaft or gear energizes counter



PUSH BUTTON REVOLUTION COUNTER • 312

Opens or closes a circuit after completing dial set number of shaft revolu-tions. Automatically resets. Start button on front knob actuates batch or flow control, piece counting, etc.



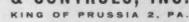
also NEW

ELAPSED TIME INDICATOR

nly \$7.55 lots of 100 to cems

Quick Delivery-for your convenience, stocks of ATC Counters and Timers' are main tained in principal cities for off-the-shelf delivery.

AUTOMATIC TIMING & CONTROLS, INC.



A Subsidiary of American Manufacturing Company, Inc.

Export Department: 1505 Race St., Philadelphia 3, Pa. In Canada: Interprovincial Industries 5485 Notre Dame St., West, Montreal 30, Quebec NEW PARTS AND MATERIALS

into impervious monolithic units and equipped with weldable leads. Capacitive element is frozen in glass. Capacitors are suited for airborne and space applications. Corning Glass Works, Corning, N. Y. Circle 678 on Page 19

Speed-Reduction Unit

for use with small-hp motors

Spur-gear speed-reduction unit for use with small-horsepower motors is equipped with a belt and pulley. Designed to operate on a polyphase motor, Barnesdril speed reducer can be used on a 110-v, single-phase motor. Reducer provides ratios of 450:1 with a 1750-rpm motor and



a 1:1 pulley ratio, and a 900:1 reduction with a 1750-rpm motor and a 1:2 pulley ratio. Wide range of reduction ratios is available. Unit can be mounted either vertically or horizontally. Model shown has a standard foot-mounted motor with an initial V-belt drive. Speed Reducer Div., Barnes Drill Co., 814 Chestnut St., Rockford, Ill.

Circle 679 on Page 19

Tube Fitting

for vacuum or pressure applications

Swagelok KayZee tube fitting consists of a brass tube-fitting body with Zytel ferrules and a brass, knurled nut for finger-tight, leakproof assembly with polyethylene tubing for vacuum or pressure applications. Fitting incorporates a wrench pad on the knurled nut to permit use of a wrench if desired. It provides a leak-tight seal on tubing of all wall thicknesses without



Dow Corning

SILICONE NEWS

for design and development engineers . No. 86

New "Product Improvers"

Since silicones can improve the quality of many components you buy, it may pay to pass on your silicone savy to your suppliers. For example, silicone additives can make a big difference in the quality of plastisol coatings and polyurethane foams—two materials of considerable promise in the product design field. Here's how—

Plastisol Coatings—Is the coating uneven or wrinkled? Does it have pinholes or cavities? Weak spots allow moisture to penetrate . . . exude rust discoloration . . . eventually chip off or flake away to expose bare metal. Why tolerate this unnecessary problem when your supplier can eliminate it by including Dow Corning Silicones in his formulation?

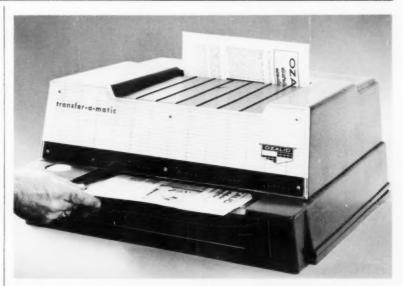
Silicones speed deaeration . . . prevent bubbles . . . cause plastisols to flow faster and more evenly. Silicones make possible thinner, lighter coatings free of cavities, pinholes and other weak spots. In many products such as furniture coverings and bushings, silicones give added "slip", improve mar and scuff resistance.



Both dishes were filled at the same time with the same plastisol solution, but a silicone additive was added to the solution before it was poured into dish at right. Note the absence of bubbles (entrapped air) in this dish.

Polyurethane Foams—Whether you use rigid or flexible foam — silicone additives can prove invaluable in helping your fabricator supply you with a high quality, low density foam that has uniform cell structure, time after time . . . that is free of partial fills, blowholes and other defects.

Your supplier will find Dow Corning silicone additives are economical, too, because lower concentrations — up (Cont. Pg. 2)



HASN'T STUCK YET!

Q: "How to get stick-proof rubber rollers?"

A: "Make them of Silastic, the Dow Corning silicone rubber", according to design and development engineers in the Ozalid Division of General Aniline and Film Corporation.

Ozalid produces the famous Transfer-amatic copying machine for office and engineering use. During field tests of early prototype models, the sensitized side of copy paper sometimes stuck to the rubber rollers that squeeze off excess developer solution as the paper emerges from the bath. The result was torn paper or a jammed machine. The problem was especially acute after the rollers had dried during periods of idleness.

Here's how the Special Products Engineering Group at Ozalid described their solution: "On the recommendation of a Dow Corning sales engineer, we had some test rollers made of Silastic. After installing them on prototype models, we put the machines (and rollers) thru operational tests that were much more severe than actual service would be. The squeegee rollers made of Silastic came through with flying colors.

"The sensitized paper stripped off these rollers without the slightest hesitancy —



under all conditions tested. What's more, neither the silicone rubber nor the developer solution reacted on each other. And no discoloration of paper has been noted. As a result, Silastic rollers are now standard equipment on all production model Transfer-a-matic machines."

Performance like this is typical of Silastic® the silicone rubber that remains resilient and tack-free despite exposure to many fluids, chemicals, steam, heat, cold, and weathering. For more information about Silastic and a list of rubber companies manufacturing parts made from this silicone rubber, circle No. 241



EDUCATIONAL "PROBE"

Taped TV lectures will become standard classroom fare in hundreds of schools in six Midwest states as Fall semesters get underway. Their point of origin: two airborne DC-6's converted by Westinghouse engineers into powerful, aerial, transmitting centers.

From 23,000 feet, the DC-6's will send TV signals having an effective range of 150 to 300 miles — many times the 60 to 70 mile range of ground based transmitters. Another advantage, each aircraft is capable of transmitting more than one lecture simultaneously on each of two channels.

With educators looking hopefully over their shoulders, Westinghouse engineers have taken every precaution to assure the most reliable functioning of the complex telecast equipment. In this department, they've had a big assist from Dow Corning silicone insulation as a means of saving weight, reducing bulk and building a high reliability factor into power supplies.

Among the items of equipment insulated with Dow Corning Silicones are:

1. Rectifier Transformer. Three single phase transformers have been combined

- to produce a three-phase rectifier transformer rated at 35 KVA, 400 cycle, to supply the 16 KV high voltage output. Total weight of 3 transformers and mounts: 165 pounds.
- Buck Boost Transformer. Three of these units are wired together to produce a three-phase transformer rated at 9 KVA. Total weight: 50 pounds.
- Filter Choke. Two units with a rating of ½ henry at 3 amperes are used in the power supply. Total weight: 50 pounds.

All units are forced-air cooled and the weights given above include the weights of the cooling ducts.

Mr. Ray Lee, components design engineer for Westinghouse Air Arm, estimates the silicone insulated transformers weigh only half as much as they would if they were Class A insulated. They help appreciably in keeping down the total weight of the transmitting equipment . . provide the ultimate in dependable operation. For more information explaining why it will pay you to investigate Dow Corning silicone insulation, circle No. 242

Announcing New Customer Service

A new customer service facility has been established by Dow Corning to render complete and comprehensive engineering service to end users and fabricators of parts made from SILICONE MOLDING COMPOUNDS.

Dow Corning developed the first silicone molding compounds about 1948. Since then, our R&D people have produced several excellent materials, noted for their resistance to high and ultra-high temperatures. Thanks also to outstanding physical and electrical properties, these compounds have gained specification in a wide variety of commercial and military applications.

In recent years the performance demands placed on silicone molding compounds have become increasingly severe. To meet these more exacting requirements, we've turned more and more to custom compounding.

This, plus the obligation we have to fabricators to help them mold these custom compounds, led us to the establishment of the new ASG (Application Service Group) Molding Compound facility. For full information on Silicone Molding Compounds and the unique engineering service available from Dow Corning, circle . . . No. 243



SILICONE ADDITIVES

to 25% less — produce consistently high quality foams with uniform cell structures.

Why not suggest these silicone "product improvers" to your suppliers? You'll get better components . . . produce better products. For more detailed information about silicone additives for plastisols, circle . . No. 244. For details about polyurethane additives, circle No. 245

Dow Cerning Corporation, Dept. 6921, Midland, Michigan
Please send me: 241 242 243 244 245

ZONE_STATE

SILICONE NEWS is published for design and development engineers by

first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C. CANADA: DOW CORNING SILICONES LTD. TORONTO OVERSEAS: DOW CORNING INTERNATIONAL S.A. ZURICK



the use of inserts. Sizes available from stock are for $^{1}/_{4}$ and $^{3}/_{8}$ -in. OD tubing. Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.

Circle 680 on Page 19

Metallic Coating

for expanded polystyrene foam

Noninflammable metallic coating for expanded polystyrene foam, designated Styro-Kote, contains no solvent and will not attack expanded styrene or collapse it. It forms a flexible, colored metallic skin which enhances the appearance of molded polystyrene. Material is easy to apply by spray, brush, or roller coater. It is available in aluminum, gold, metallic red, blue, green, and yellow, and is packaged in 55-gal drums and 1 and 5-gal containers. Adhesive Products Corp., 1660 Boone Ave., New York 60, N. Y.

Circle 681 on Page 19

Gasoline Engines

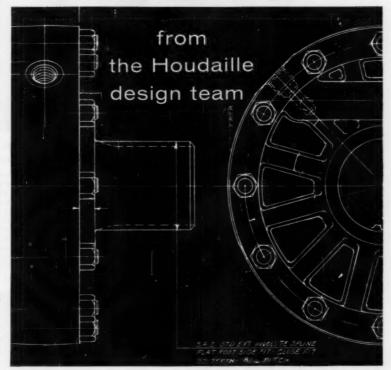
in either 2.5 or 3.5-hp units

Tecumseh VI and VII air-cooled gasoline engines for rotary lawn mowers and other garden equipment are two-cycle engines with 2.5 and 3.5 hp, respectively. Mechanical flyball governor maintains optimum operating speed of 3200 rpm. All components are close coupled to power head to eliminate harmonic vibrations and to provide ease of styling. Both engines are die-cast aluminum with bronze



(Please turn to Page 274)

NEW



SIMPLEST HYDRAULIC ROTARY ACTUATOR A BACKHOE EVER HAD

Objective: to design a hydraulic rotary actuator that would give rugged service when used to control horizontal positioning on a backhoe boom. Like all Houdaille designs, this must incorporate top quality construction and high operating efficiency. Operating at 2250 p.s.i. the unit has a torque of 68,500 inch pounds with an angular travel of 220°.

Result: Houdaille now can offer manufacturers of construction equipment a superior hydraulic rotary actuator designed especially for backhoe installation. We are prepared to work on your rotary actuator problem too! Write us today.



... Specialists in rotary type hydraulic equipment

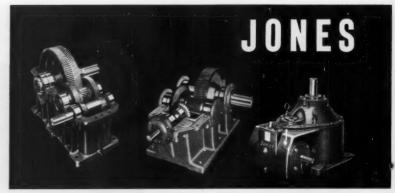
Houdaille Industries, Inc.

Buffalo Hydraulics Division . Dept. B . 537 E. Delavan Ave., Buffalo 11, N.Y.

How

THE BROAD H-R LINE

can pinpoint
your needs,
save you time
and give you
off-the-shelf
savings.



Jones herringbone reducers...

Ruggedness and reliability, known throughout industry. Widest selection of sizes and ratios. Balanced design, rugged housing, heavy-duty bearings mean efficient, trouble-free operation, and longer life. Capacities to 1,672 hp. Bulletin J-100.

Jones spiral bevel speed reducers...

Most-up-to-date design. Horizontal or vertical outputs. New, highly efficient right angle drives. Matched sets of high-hardness spiral bevel gearing, oversize bearings, alloy steel helical gearing. Capacities to 1,050 hp. Bulletin J-25.

Jones worm helical speed reducers . . .

Heavy duty service. Applicable to a wide range of vertical drive requirements where medium to high speed reduction ratios are needed. Available in low speed shaft extension up, down, and double extended. Capacities to 175 hp. Bulletin J-14.



Union ASA standard roller chain...

Over 98% efficient, Union ASA standard roller chain transmits more horsepower in less space than many other mechanisms. Available in outstanding range of pitches and widths, ASA standard and ASA heavy series, and extended pitch. Bulletin RT-60.

Roller chain attachments...

An almost unlimited variety of unusual drive and conveying problems can be solved with standard or special attachments by Union Chain.

Bulletin RT-60.

Union roller chain sprockets...

Complete range of stock and special sprockets for all chain applications. Precision teeth, tough, durable body, proper tooth surface hardness make for long life and economy. Available also in Taper-Lock bushings. Bulletin RT-60.

YOUR H-R POWER TRANSMISSION SPECIALIST CAN SHOW YOU HOW...

to select the ratio, capacity, and design closest to your needs . . . directly from H-R standard equipment . . . and at "off-the-shelf" savings.

Another point in your favor: your H-R power transmission specialist is in the best position to help you

select the right drive. He can recommend without bias, because the H-R line is one of the most comprehensive in industry. Experienced in all phases of power transmission, he can be invaluable in helping you with your over-all drive problem. Important too, he has Hewitt-Robins service and reliability behind him!

Availability? H-R warehouses, sales offices, and stock-carrying distributors spread a strategic network from Coast to Coast. There is a team of H-R

SPEED REDUCERS

Jones shaft-mounted reducers . . .

Compact design for confined areas. High hardness gearing for long life. Double lip oil seals, anti-friction bearings, automatic overload mechanism, positive lubrication. Torque-arm for simple belt tensioning adjustment. Capacities to 40 hp. Bulletin J-19.

Jones in-line helical reducers...

Standardized components, both in-line and right angle reducers to meet any drive requirement.
Easy-to-change ratios.
One-piece, cast housing, positive gear and shaft alignment, reliable oil-sealing. Capacities to 147 hp.
Bulletin J-18.

Jones gearmotors...

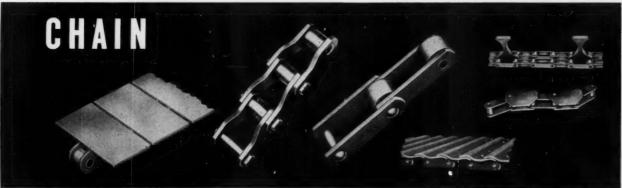
Horizontal or vertical, flange or foot-mounted. Two basic types: All-motor... has motor mounting bracket for foot-mounted motor. Integral... incorporates flange-type motor bolted directly to gearhead housing. Bulletin J-17.

Jones power transmission components...

Pillow blocks for heavy-duty service. Timken tapered roller bearings, two-piece, cast iron housing, shaft sizes from 1 15/16" to 9". Flexible couplings, gear tooth, fabric disc... V-belt drives... cut tooth gears... cast iron pulleys. Bulletins J-10A, J-16, J-23.

Jones complete drive units...

Safe, efficient special drives, feeder tables, car pullers, door, boom, and skip hoists. Feature rugged reliability of Jones speed reducers. Standard lines available or modifications of existing equipment at considerable savings. Bulletins J-11, J-22.



Union ASA standard flat top roller chain...

Now available in Delrin, (as well as other materials) reduces breakage and eliminates corrosion problems in many food, beverage, and pharmaceutical conveyor applications. Available in many combinations of chain and materials. Bulletin RT-60.

Union HB steel drive chain...

At home in heavy duty service, such as cement mixers, cranes, shovels. Offset side-bar adds to flexibility. Hardened bearing for rugged wear. Pitches from 1.6" to 6.0". Average ultimate tensile as high as 420,000 psi! Bulletin A-4.

Union HB steel roller chain...

Low ultimate cost in all types of elevating and conveying duty. Hardened alloy steel bushings, uniform wearing surfaces, true pitch accuracy, tight fit of pins and bushings. Bulletin A-4.

Union apron conveyors . . .

Many types available. Union apron conveyors for bulk or packaged materials. Bulletin A-4.

Union "Made-to-order" chain . . .

Meet unusual requirements. Union Chain Division of Hewitt-Robins, unlike many manufacturers, is able to design and produce special chains to meet special needs. Bulletin A-4.

power transmission specialists in your territory. To put them to work for you, just give your nearest Hewitt-Robins Sales Office a call.



CONVEYOR MACHINERY AND BELTING . HOSE POWER TRANSMISSION . VIBRATING EQUIPMENT ENGINEERING SERVICES

		OBIN	-	ORD,	CONF	IECTI	CUT			
	leme se se		the 1	ollowi	ng bu	lletins	s:			
J-10A	J-11 J-22	1-14	J-16 J-23	J-17	J-18	J-19	J-25	J-100	RT-60	A-4
Signed				Title						
Com	pany_									
Addi	ess_									

Fabrication...





For instance, Crane Packing Company's new Teflon products plant was especially designed to obtain the highest quality fabrication of this material and includes the very latest in extruding, molding, curing and machining equipment. Result: parts and components that retain all of Teflon's outstanding electrical, mechanical, anti-corrosive, heat-resistant and other properties.

Whether you get this quality depends on your selection of a fab-

ricator. Why not choose the best?



CRANE PACKING COMPANY

6425 Oakton Street, Morton Grove, Illinois (Chicago Suburb)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

Circle 358 on Page 19

NEW PARTS AND MATERIALS

(Continued from Page 271)

bearings on connecting rods and power take-off end of crankshaft. Standard equipment includes an automatic rewind starter. Lauson-Power Products Div., Tecumseh Products Co., Grafton, Wis.

Circle 682 on Page 19

Pilot-Light Bulb

is small, 6-w unit

New incandescent lamp for operation on standard-voltage circuits is a 6-w unit, 1/2 in. diam and 1 7/16 in. long, including candelabra screw base. Use permits miniaturization of pilot-light assemblies used on industrial and electric equipment. Two separate 3-w, low-voltage, coiled tungsten filaments are connected in series. Lamp uses two



mounts, one to support each filament. It produces 36 lumens of light. Filament design spreads the light so that it can be used effectively with lenses of all colors in dial lights or other indicator applications. Voltage rating is 125 v. Average life is 1500 hr. Large Lamp Dept., General Electric Co., Nela Park, Cleveland 12, Ohio.

Circle 683 on Page 19

Fluid Motors

in speeds to 2000 rpm and pressures to 2000 psi

MID vane-type fluid motors are offered in five models, producing maximum torques of 1249, 1719, 1897, 2160, and 2345 lb-in. at 2000 psi. Units are furnished in speeds to 2000 rpm and pressures to 2000 psi. Floating port plate construction has a built-in shuttle valve which keeps the plate under uniform pressure load, regardless of flow through the motor. Four-bolt,

Gusher

Coolant Pumps PRECISION



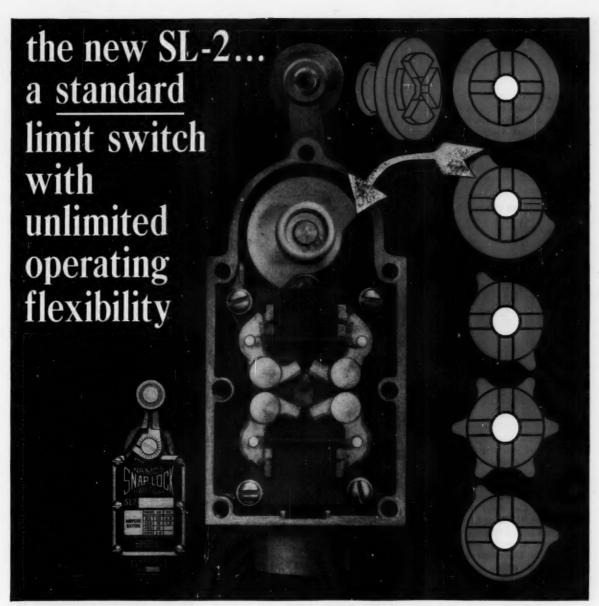
- LAST LONGER
- PERFORM BETTER ON YOUR MACHINES

You get better performance from your GUSHER Coolant Pumps because they are precision built. The one piece shaft in GUSHER Pumps is electronically balanced to cut vibration to a minimum. Ball bearings are pre-lubricated, no seal or packing needed. Write for catalog.



- CIRCULATORS . AGITATORS

1811 Reading Road . Cincinnati 2. Ohio



Tailor limit switch performance to your specific job with NAMCO'S standard SL-2. This "machine life" limit switch features a standard cam blank which can be cut into a wide variety of configurations to meet any application. These interchangeable cams provide positive control of contact sequence; let you match switch operation to your specific job. Ruggedly built, oil-tight and moisture-proof, the SL-2 provides dependable, accurate performance that meets your most precise requirements.

Now available for low-current, high-shock, excessive-vibration applications...the SLS-2...

with full-wiping, self-cleaning sliding contacts that insure "everytime" operation under conditions that spell machine downtime for other limit switches.

Get all the details on how the NAMCO SL-2 line eliminates limit switching problems for good. Write for Bulletin EC-SL260, or contact one of our representatives. You'll find them in all principal cities.

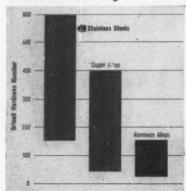
National Acmo Acme Company Acme Company

Sales Offices: Newark 2, N. J., Chicago 6, III., Detroit 27, Mich.

stainless steels give design engineers a wider application range

In your constant search for materials that serve a wide range of design applications, investigate the performance characteristics of Carpenter Stainless Steels. The following data highlight several important reasons why these versatile steels continually deliver bonus benefits to both design engineers and manufacturers.

Greater hardness range



Only stainless steels can give you the combination of good corrosion resistance with sufficient range of hardness to meet any of your requirements. For example, fully annealed 18% Cr-8% Ni stainless steels such as Carpenter Stainless No. 4-A (Type 304) have a Brinell hardness of about 150, whereas heat treated Carpenter Stainless No. 440-C (Type 440C) can be as hard as 600 Brinell and both materials offer excellent resistance to a wide variety of corrodents. The range of hardnesses available with either copper-base or aluminum-base alloys is much smaller.

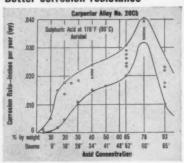
Superior machinability



The selection of Carpenter Stainless

No. 5 (Type 416) for this level wind shaft for a fishing reel gave the manufacturer good machinability and eliminated expensive handwork on the shaft. It also provided excellent resistance to corrosion and unbeatable wearing qualities. A good example of a wise choice in metal selection.

Better corrosion resistance



The wide range of stainless steels available offers the designer the exact degree of corrosion resistance necessary for almost any corrosive environment. For mild corrodents, inexpensive Carpenter No. 1 (Type 410) can be used; for extremely severe corrodents such as hot sulphuric acid solutions, Carpenter No. 20Cb should be specified. For other corrodents, one of the many other stainless steels will be the most economical material for you to use.

Carpenter No. 20Cb is a special alloy first produced by Carpenter in wrought form. Its excellent resistance to hot sulphuric acid is shown in the chart above. For information on its resistance to other corrodents, send for booklet, "Super Corrosion Control."

Easier quality control

Here's an application where Carpenter Stainless No. 8 (Type 303) provided an unexpected bonus! These bushing and shaft assemblies for a push-button unit in an explosion-proof switch were formerly made from a non-ferrous metal. After switching to Carpenter Stainless No. 8 (Type 303) to gain

more uniform machinability and noncorrosive properties, this customer eliminated a costly inspection operation on the finished shafts. This was due to the consistently true size of the No. 8 bars (total tolerance: .0005" as supplied by the Carpenter mill).



Carpenter Stainless is available to the designer in many forms. Billets, bars and wire in a wide range of sizes. strip, tubing or pipe of varying thicknesses. Whatever form best suits your needs, you'll find one unique feature of Carpenter Stainless . . . its consistent uniformity. There's never the slightest change in composition in any one grade of Carpenter Stainless, no matter how big the order. Day after day, year after year, each melt of Carpenter Stainless is carefully controlled with the best equipment and human effort to bring you a reliable, consistent material, unsurpassed in uniformity. When the product you design goes into production, this consistent uniformity becomes extremely important. Specify Carpenter Stainless, and take a big step toward approval of your project.

Technical data available



Complete information on properties and characteristics of all grades of Carpenter Stainless is available in data sheet form. Send for yours today.

Carpenter steel

you can make it consistently better with Carpenter Stainless Steels for specialists

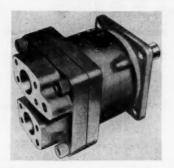


The Carpenter Steel Company, Main Office and Mills, Reading, Pa. Export Dept., Port Washington, N. Y.—"CARSTEELCO"

Alloy Tube Division, Union, N. J.

Webb Wire Division, North Brunswick, N. J.

Carpenter Steel of New England, Inc., Bridgeport, Conn.



SAE flange-type mounting is provided as an integral part of the housing. Mounting brackets are also available. Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio.

Circle 684 on Page 19

Hose Clamp

provides deep-slotted screwdriver slot

Series H Sure-Tite worm-drive hose clamp incorporates a hex-head screw. Clamp provides a deep-slotted screwdriver slot and %-in. head is standard for any socket hex wrench or open-end wrench. Unit provides fast, tight clamping in all applica-

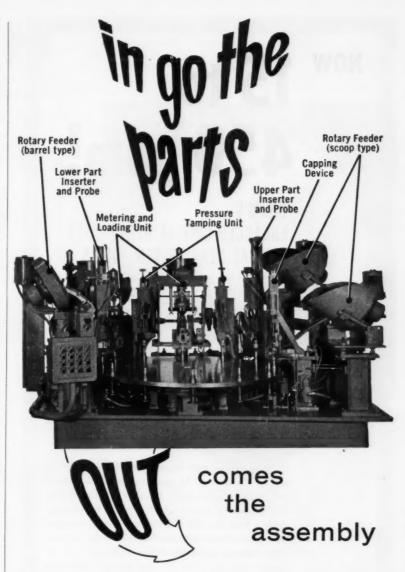


tions. Wittek Mfg. Co., 4305-43 W. 24th Place, Chicago 23, Ill.

Epoxy Molded Resistors

range from 1/10 to 1 w

Series of epoxy-molded precision carbon and metal film resistors maintain precise stability without change in characteristics. Utilization of a larger core size for a given wattage provides increased film surface area. Resistors, ranging from 1/10 to 1 w, exceed requirements of MIL-R-10509D, characteristics B, D, and F for the carbon film, and characteristics C and E for the metal film. X-ray photo shows comparative core



faster... better... at lower cost with a DPS special assembly machine

Micro-parts, or parts many, many, times their size . . . parts of almost any shape or material go together fast, automatically, and accurately in DPS special assembly machines. DPS experienced engineers will combine rotary feeders . . . vibratory feeders . . . elevating feeders . . . and power screwdriving machines with other processing equipment to feed, orient and assemble parts. If you have an assembly problem, let a DPS engineer analyze your production line. DPS special assembly and processing machines can give you higher-speed production . . . better quality control . . . and substantial reduction in assembly costs. Write today.



DETROIT POWER SCREWDRIVER CO.

A Subsidiary of Link-Belt Company

Selective Parts Feeders; Screw, Nut and Stud Driving Machines; Special Purpose Assembly Machines 2801 W. Fort Street Detroit 16, Michigan TAshmoo 5-3070

15,726

15 to 450 gpm!

VIKING'S ENLARGED LINE OF HEAVY DUTY HELICAL GEAR DRIVEN PUMPS

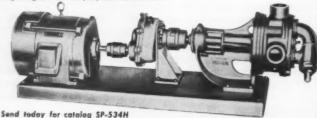


Figs. 288 and 388 units with size "C" reducers, capable of handling up to 25 H.P. at 350 pump R.P.M.; 40 H.P. at 520 pump R.P.M. 20 to 450 G.P.M. capacities. Five gear ratios available, using one gear case. Six pump sizes in this series.

You now have an even larger range of Viking's helical gear driven units to fit your pumping jobs. Speed and capacity now range from 15 to 450 G.P.M. They're ideal for handling both thin and thick liquids, ranging from gasoline to molasses. Pumps equipped with packing or mechanical seals. Gear reducers independently mounted. All components can be quickly changed. Step up your delivery with these quiet, positive discharge, self-priming pumps!

BELOW

Fig. 288 units with size "B" reducers, capable of handling up to 10 H.P. at 1750 R.P.M. motor speed. 15 to 225 G.P.M. capacities. Six sets of gearing using one gear case. Six pump sizes in this series.



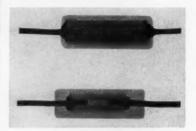
VIKING PUMP COMPANY

Cedar Falls, Iowe, U.S.A. . In Canada, It's "Roto-King" Pumps

See Our Catalog in Sweet's



Product Design File



size of new series of resistors in relation to standard resistor core of the same size and wattage. **Key Resistor Corp.**, 321 W. Redondo Beach Blvd., Gardena, Calif.

Circle 686 on Page 19

Thermoplastic Resin

with thermal stability from -400 to +400 F

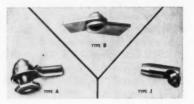
New thermoplastic resin, Kel-F 81 plastic, is offered in two grades, based upon molecular weight, in pelletized and unpelletized and plasticized forms. Thermal stability ranges from -400 to +400 F. Material resists a wide range of chemicals, fuels, and corrosive media. The plastic is suitable in the fields of missiles and rockets, as well as in conventional applications in electric and electronic products, valve seats, stems and diaphragms, Orings, and gaskets. Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 687 on Page 19

Ball Joints and Pivots

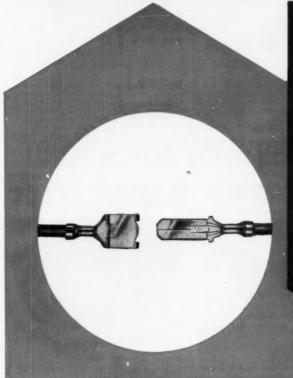
are made with a ring bearing and a hollow stud

Low-cost line of linkage ball joints and pivots is available in all sizes from miniature units to large ones used on heavy machinery and automobile steering joints. Construction with a hollow stud and a ring bearing results in low stresses at critical points and gives the unit highload capacity. Six basic categories are available, four of linkage ball



HIGH

20-25 amperage rating for greater design flexibility...choice of 7, 14 or 20 way circuit blocks.





LOW

2-5 pounds insertion and extraction force for easier installation and servicing.

NEW AMPEEZ CONNECTOR GIVES YOU BOTH

Here is a workhorse of a connector! Housed in tough nylon and designed to carry as many as 20-circuits while holding insertion-extraction forces to 2-5 pounds, AMPEEZ Connectors are adaptable to many applications calling for a heavy-duty, easily serviced multiple-circuit disconnect.

AMPEEZ Connectors will match your application needs perfectly . . . anything you call for up to 20-circuits and 25 amps. One other major feature! AMP's exclusive Tab-Gap Lok assures a constant contact pressure even under the severest vibration conditions.

Use AMPEEZ Connectors, eliminate the human error in individual connections . . . make them fast and safe. Send today for AMPEEZ Connector literature and sample of tab and receptacle with Tab-Gap Lok.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA
AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

September 14, 1961

Circle 364 on Page 19

279

the NEG'ATOR Data Book

HUNTER Stanse in Springs 3. MECHANICAL

MOTORS

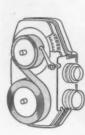
Using NEG'ATOR springs to produce constant torque



1. The NEG'ATOR spring is a strip of spring steel formed into a prestressed coil. It resists uncoiling with a uniform pull—provides a truly constant-force spring of practically any length.



2. By reverse winding the free end around a second, larger drum, we can utilize the tendency of the material to recurl to its preset curvature to make a powerful, long-running NEG'ATOR motor.



3. Thus, the NEC'ATOR motor releases maximum useful energy at constant-torque output from full wind to run down. Associated components, can be greatly simplified because there is no exaggerated torque peak.



4. In counterbalancing, very long vertical travel is possible from a compact NEGATOR unit concealed overhead, or even in the moving unit.



5. Reeling in long cords or retracting cable-connected loads is another NEG'ATOR function made possible by its great length, smooth action and constant-force properties.



6. As an anti-backlash device, a NEG'ATOR motor ensures immediate response without lag. Constant-torque load can be applied over slight movement or over many, many turns.

7. Six stocked models of NEG'-ATOR motors are available to designers for test or assembly purposes. These models provide cable tensions of $\frac{3}{2}$, 1, 2, 3, 4 and 5 lbs.



How to use NEG'ATOR Motors?

■ Movie cameras, valve operators, recording instruments, satellite recorders, timers, X-ray apparatus, lighting fixtures, appliance cord retrievers, and other familiar products use NEG'ATOR motors, reels and counterbalances. Write for details.

The NEG'ATOR spring is a development of Hunter Spring Company.



HUNTER SPRING COMPANY
A Division of American Machine and Metals, Inc.

3 Spring Avenue, Lansdale, Pennsylvania
ULysses 5-6815 TWX: 982-U

DIVISIONS OF AMERICAN MACHINE AND METALS, INC.: Troy Laundry Machinery Richle Testing Machines • De Bothezat Fans • Tolhurst Centrifugals • Filtration Engineers • Filtration Fabrics Niagara Filters • United States Gauge • Rahm Instruments • Lamb Electric Co. • Hunter Spring Co. • Glaser-Steers Corp.

NEW PARTS AND MATERIALS

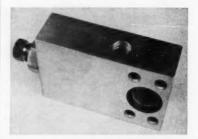
joints and two of linkage pivots. All sizes and specifications can be made to order, and some units are available from stock. Choice of steel or stainless steel on all units is provided. Link-Age Corp., P. O. Box 92, East Station, Yonkers, N. Y.

Circle 688 on Page 19

Relief Valve

has capacity of 3000 psi

Direct-operating relief valve, Model 513, is designed for mounting on all hydraulic pumps having standard SAE ½-in., four-bolt connectors. Valve has a capacity of 3000 psi, and features a low differential be-



tween opening and full flow. Pressure control is by adjustment of a single set-screw with lock nut. J. E. Myles Inc., 2406 Hilton Rd., Detroit 20, Mich.

Circle 689 on Page 19

Adjustable-Speed Drives

are now reversible

Reversible adjustable-speed drives are now available in Zero-Max 400 Series. Reverse control is a separate knob or lever operated independently from the speed-control level. It can be ordered on 33 of the 35 basic fhp models. Reversing the direction of input on the drives does not reverse the output. Direction of output can be changed whether or not the drive is running. Reverse on the smaller drives is accomplished by reversing the direction of the drive of the overrunning clutches in the output section. On the larger drives, reverse is accomplished by a bellcrank and gear arrangement in a gearhead. Reverses also provide a neutral position in which the output shaft is disengaged and can be rotated manually in either direction. Speed ranges





million cycles in a test machine.

Now, contravanes made of glass fiber impregnated with a BAKELITE 11½ per cent.

Epoxy resin-glass fiber helicopter part is stronger, lasts 5 times longer than Brand epoxy resin are being used in this important assembly. Manumetal. Air deflecting contravanes, mounted directly on the engines of factured by the Fibremold Division, Hampden Brass and Aluminum Sikorsky S-58 helicopters, are subjected to engine vibration. Formerly made from metal, such contravanes became inoperative after about 3 million cycles in a test machine.

New York of the power o

TO GAIN STRENGTH, REDUCE WEIGHT, SAVE TIME ...design it with easy-to-fabricate epoxies





Epoxy-glass "spinners" dampen vibration, maintain strength despite alternate icing and heating. Predicted long, reliable service life is one of the outstanding features of epoxy resin-glass cloth propeller "spinners" now being used on Grumman "Mohawk" airplanes.

The epoxy-glass cloth "spinners," which incorporate de-icers for the aircraft's propellers, possess excellent tensile strength and fatigue resistance—very important properties for a part that is subjected to

vibration. The wire heating elements, that are laminated right restrict vibration. The wife heating elements, that are laminated right in with the glass cloth and impregnated with a Bakellet epoxy resin-based compound, have excellent electrical insulation. The strength-to-weight ratio of the "spinner" is high.

In addition, the manufacturer, Fibremold Division, Hampden Brass and Aluminum Company, reports that production costs are substantially lower since using the epoxy resin-based compound.



New and practical applications for epoxy resins—often in combination with other materials, such as glass fiber and metal-are being introduced by ingenious designers in many fields. No other resin commercially available offers so many advantages: exceptional strength-stronger than other plastics-even under wide temperature ranges . . . excellent resistance to most chemicals, water and weather . . . ease of fabrication that saves untold hours of production time and costs. Some of the newer applications for epoxy resins include filament winding, electrical encapsulation and embedment, fabrication of large storage vessels and containers.

For more information about BAKELITE Brand plastics-epoxies, polyethylenes, phenolics, styrenes, vinyls, and polypropylenesmail the coupon today. See Sweet's Product Design File, section 2a/ui, for a list of properties.

BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

Epoxy resin-glass cloth laminate saves 80% of cost of large laminating tool. The Tapco Group of Thompson Ramo Wooldridge Inc. has dramatically proved the merits of epoxy-glass laminate tooling. A parabolic-shaped laminating tool about 15 feet long and seven feet across was built of Bakelite epoxy resins laminated with glass fibers. The big tool, its surface smooth and flawless, was made and placed in production in a minimum amount of time. The company claims this epoxy-glass tool saved them approximately four-fifths the estimated cost of a tool made from other materials.



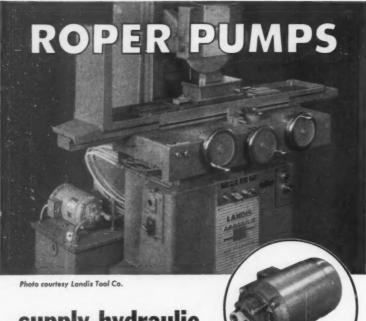
PLASTICS

Dept. FD84P, Union Carbide Plastics Company Division of Union Carbide Corporation 270 Park Avenue, New York 17, N. Y.

Please send me information on BAKELITE resins and suggested applications. I am especially interested in

FIRM NAME

STREET ZONE STATE



supply hydraulic oil to surface SERIES T grinder hydraulic system

. CAPACITY: .3-55 GPM

PRESSURE TO 400 PSI

The hydraulic system controlling the hydraulic table traverse and hydraulic crossfeed on this Landis 618 precision surface grinder is activated with a Roper Fig. 11TM748 pump and motor unit. The Series T hydraulic pump motor is the bell end of the 3/4 hp, 1800 rpm electric motor. It delivers 2.8 gpm 150 SSU hydraulic oil at 200 psi. Landis Tool Co. has been using this Roper hydraulic pump motor on the 618 since introducing this hydraulic surface grinder in 1960. Many original equipment manufacturers requiring transfer, hydraulic or pressure feed work with clean liquids have found that Roper Series T pumps fit their specifications. There are 192 models of the Series T pump. Get full information about this efficient unit for your equipment.

PRECISION HANDLING OF HYDRAULIC WORK

- PUMP GEARS are steel, hobbed and shaved for balanced, quiet operation. Driven gear mounted on motor shaft eliminates couplings, reduces space.
- BRONZE BEARING in backplate assures proper alignment of driving and
- MOTORS for Series T units are open drip proof or totally enclosed types. Standard NEMA frame sizes are used throughout the series.

For information about your specific pump needs contact your nearest Roper dealer

Send for "How to Solve Pumping Problems" booklet

ROPER HYDRAULICS, INC.

Dependable pumps since 1857 COMMERCE, GEORGIA



on reversible models are from 80-0-80 rpm to 1200-0-1200 rpm with 1800-rpm input. Torque ratings are available from 3 through 450 lb-in. Zero-Max Co., 2845 Harriet Ave. South, Minneapolis 8, Minn.

Circle 690 on Page 19

Solenoid-Release Switchlights

are available in 14 circuit types

Miniature solenoid-releases switchlights operate as regular push-on, push-off switches which also can be released electrically from a remote position. Fourteen circuit types are available up to 4PST and 2PDT. Switch is rated at 28 v dc, 125 v ac up to 2 amp resistive. Coils are available at 6, 12, and 28 v. Two types of plunger action are also available. Complete envelope is 25/8 in. long; case diameter is 3/4 in. Lamp circuit is independent, uses



T-1 3/4 lamps. Standard single and dual-lamp pushbuttons can be removed manually for rebulbing from the front of the panel. Pendar Inc., 14744 Arminta St., Van Nuys, Calif.

Circle 691 on Page 19

Transparent PVC Tubing

transmits active chemicals or materials

Clearflo transparent PVC tubing transmits gases, acids, alkalies, petroleum products, sea water, and other active chemicals or materials. Tubing is nonporous, has mirror-



New Precision "O" Ring Development Cracks A Service Barrier

Two new Precision Compounds*, both gamma radiation resistant to maximum total dosage of 1 x 10° roentgens, open up new horizons of sealing in nuclear systems. They cover a wide range of fluid applications. This major scientific development extends Precision leadership in the development and production of "O" rings.

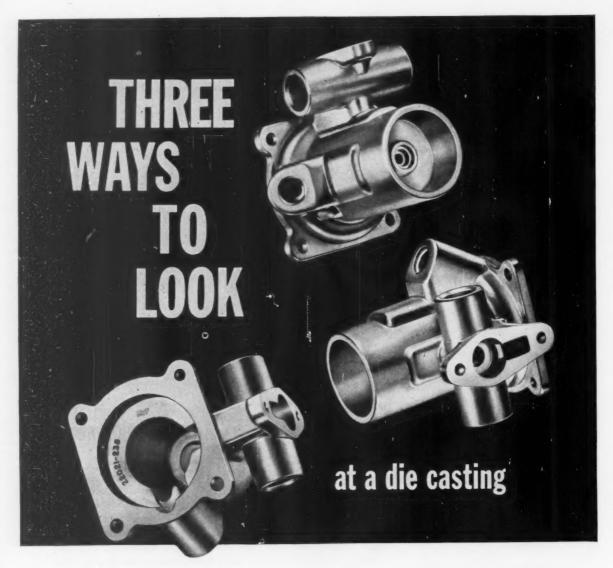
The quality of all Precision "O" Rings, whether produced for nuclear service or standard industrial use, is a matter of recognition and record. In your product, that quality protects the high performance standards you set for it . . . preserves reliability and reputation. Be sure you have the right "O" ring for your product, made from the right compound by specifying Precision. Call for the services of a Precision engineer today.

* Complete engineering data on these new compounds - 1387 and 4387 - available on request.
Ask for bulletin in No. 5041

recision Rubber Products Corporation "O" Ring and Dyna-seal Specialists

Dept. 431, Oakridge Drive, Dayton 17, Ohio

Canadian plant at: Ste. Thèrése de Blainville, Québec



Madison-Kipp zinc and aluminum die castings

Here is a gas valve housing so intricate no one view could do it justice. Notice that the holes which are cast in reduce secondary operations. Cast in seats must be smooth and flat to prevent any danger of leakage. Dimensions must be held to close tolerances.

There are three ways to look at a die casting. First, the engineering that goes into the design and the skilled die making that assures perfect castings. Second, the experience of the die caster that guarantees

quality parts in quantity. Third, his reliability and responsibility backed by years of die casting experience.

On all three counts—engineering, production, responsibility—Madison-Kipp has won the confidence of manufacturers who demand the finest.

We have a 24-page book showing some of the die casting problems we have solved, and containing information on other Madison-Kipp products. A copy is yours for the asking. Write for one.



MADISON-KIPP CORPORATION

210 Waubesa Street • Madison 10, Wisconsin, U.S.A.

Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High-Speed Air Tools

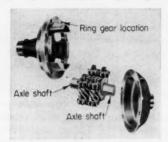
like interior and exterior surfaces which resist staining, bacterial growth, and dirt accumulation. For use with high pressures and to resist crushing, tubing is also available in two reinforced versions, one with a steel wire spring and the other with a nylon braiding having burst pressures to 1000 psi. Newage Industries Inc., 222 York Rd., Jenkintown 46, Pa.

Circle 692 on Page 19

Full-Time Differential

has no clutches, springs, other small parts

Dual Drive full-time differential is low in cost, easy to install, simple in design and operation. It consists of two basic operating parts—a balancing gear and a side gear. New differential has no clutches, springs, locks, or manual controls. A system of gears, acting as driving keys, transmits engine power



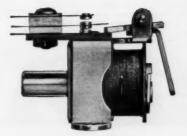
to the rear wheels in exact ratio to the traction resistance of the wheels when the vehicle is in either forward or reverse motion. Dual Drive Inc., 3597 Lee Rd., Cleveland 20, Ohio.

Circle 693 on Page 19

Teflon Tape

has nonstick surface and chemical inertness

Type IT cast Teflon film has a pressure-sensitive backing that permits continuous usage to temperatures of 350 F and short-time application to 400 F. Tape consists of a laminate of Type S Teflon film bonded to a high-tack adhesive layer. Tape adheres to various surfaces including glass, metal, wood, and ceramics. It is suitable for many electrical and mechanical applications such as slot lining, harness bundling, and spot



"twofer"

With Heinemann's Type A Silic-O-Netic®, you get two relays for the price of one: a time-delay relay and a load relay. In one small package (shown actual size above), you get a time-delay relay that can double, if you wish, as a load carrier, too. (It's got a continuous-duty coil; you don't have to use auxiliary lock-in circuits or slave relays.)

The Type A tips the scale—barely—at three ounces. It comes with any delay you spec, from a quarter-second to two minutes, can be supplied for use on any one of twenty standard AC or DC voltages. Contact capacities range up to three amps. Maximum power consumption is two watts AC, three watts DC. Switching is SPDT or DPDT. Operating life is somewhere in the millions (the hydraulic-magnetic delay element is hermetically-sealed, fatigue-free).

The Type A (and the entire line of Heinemann time-delay relays) is described in full in our Bulletin 5003. A copy is yours for the asking.

HEINEMANN ELECTRIC COMPANY

172 BRUNSWICK PIKE



TRENTON 2, NEW JERSEY

Gibson Atomiclad* Electrical Contact Rivets now available in economical Gibson Assemblies ATOMICLAD RIVETS ARE LOWER COST BECAUSE IT COSTS LESS TO MAKE THEM



Patents Pending

And they're BETTER because their bond of dispersed atoms of the precious contact metal and the base metal of the body is electrically and mechanically superior to other bonding methods. Cost is further reduced by limiting use of precious metal to electrical requirements

Atomiclad Rivets are made in all standard forms and of copper, steel or other base metal with contact face of precious or semiprecious metals.

Many sizes and types are stocked in quantity. Write for Standard Stock List #2007, and for Technical Information Bulletin 400.

ECONOMICAL GIBSON CONTACT ASSEMBLIES

Gibson contact support manufacturing facilities include every phase-forming, riveting, heat-treatment and electroplating

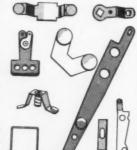
and comprises use of any specified metal.

When you specify Gibson Contact Assemblies, you get the years of engineering know-how in providing the best possible electrical union between contact and support member. Since all assemblies are Gibson-inspected, the cus-

tomer suffers no loss through assembly rejects.

Gibson Engineers will design your complete contact assembly upon receipt of specifications. Or send your drawings for fabrication costs. If you prefer your own support member, send a sample for assembly cost.

*ATOMICLAD-Trademark Gibson Electric Company



ibsilou

GIBSON ELECTRIC SALES CORP.

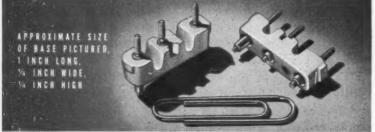
BOX 614 DELMONT, PA

BOSTON CHARLOTTE CHICAGO CLEVELAND DAYTON
DETROIT LOS ANGELES NEW YORK PHILADELPHIA PITTSBURGH
ROCHESTER ST. LOUIS SAN FRANCISCO SEATTLE

Circle 371 on Page 19

Here's How Haveg Solved the Problem...

PRECISION MOLDED RIGID INORGANIC INSULATING MATERIAL



This miniature switch base molded with Havelex, contains four different stainless steel inserts with precious metal plating. Three inserts (which include \$0.80 male threads) or all the way through the mold and provide precision mountings on both sides for assembly. The \$0.80 female threaded insert is designed to protrude from one face and is approached by a molded counterbore from the other. Mold is designed to accommodate alternate terminal inserts when unthreaded models are required.

Haveg engineers recommended Havelex for this particular molding because of its combination of properties. Completely inorganic, with metal inserts integrally molded in place. Precision tolerances with faithful reproduction from part to part. Heat resistance for continuous operation in excess of 700°F

Haveg engineers will be happy to work with you on your particular project—to help you "Keep ahead with Haveg," Remember—Havelex offers all of these unique features: Dimensional Stability • 1000°F. Continuous Temperature Resistance • Dielectric Strength • Mechanical Strength • Low Loss, Low Power Factor • Arc Resistance • No Moisture Absorption • Integrally Molded Metal Inserts • Hermetically Sealed Inserts.

Koop Ahond with

TAUNTON DIVISION HAVEG INDUSTRIES, INC.

336 Weir Street - Taunton, Massachusetts

Telephone VAndyke 4-4011

NEW PARTS AND MATERIALS

insulation. Tape has nonstick surface and is chemically inert. It is impermeable to moisture, gases, and organic vapors. Tape is available in 2. 3. and 4-mil Teflon-film thicknesses, with an adhesive thickness of 11/2 mil. Widths range from 1/4 to 12 in. in increments of 1/8-in. Dilectrix Corp., Allen Blvd. & Grand Ave., Farmingdale, L. I., N. Y.

Circle 694 on Page 19

Caster Wheels

have resilient durable tread



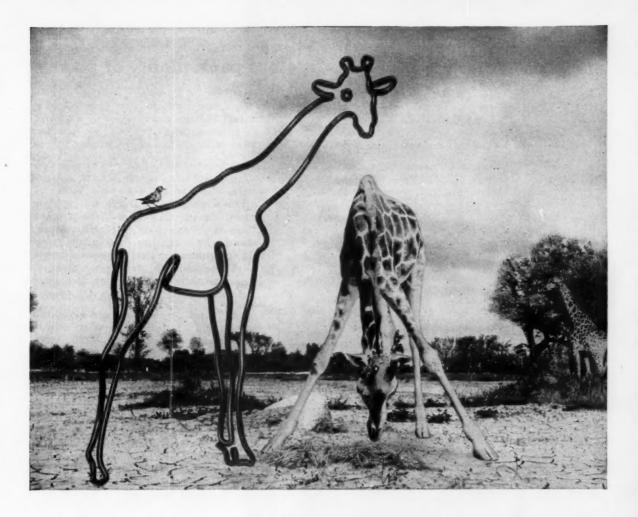
Caster wheels have long-wearing, high-load-capacity tread of Adiprene. Tread is more durable than rubber, has a resiliency that absorbs vibrations and rolls quietly, and permits easy starting and rolling for wheels. It is not affected by chemicals, petroleum products, mild acids, alkalis, weathering, or ozone conversion. Treads do not mark floors or pick up concrete particles. Wheels with the new treads are available in both swivel and rigid-model casters. Wheel diameters range from 31/2 to 8 in. with load ratings from 400 to 1300 lb. Wheels with $1\frac{1}{2}$ to 2-in. tread have double-sealed bearings. Rapids-Standard Company Inc., 342 Rapistan Bldg., Grand Rapids 2, Mich.

Circle 695 on Page 19

Photoelectric Scanner System

has operating range to 8 ft

Requiring no tubes or transistors, Type PE-1 photoelectric scanner system provides positive response when the light beam is interrupted by objects as small as 1/4-in. wide at counting rates to 500 per min. Depending on the light source and photocell used, operating ranges

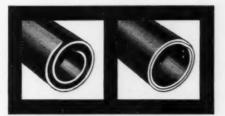


Bundy can mass-fabricate practically anything

No matter what tubing components you may need, chances are Bundy can mass-fabricate them better. Bundy engineers design their own mass-fabrication machinery—can often point

out modifications that mean important cost savings for you. And there are few things you can't make with Bundyweld® steel tubing. It meets Government Specifications MIL-T-3520, Type III; ASTM 254; and SAE

specifications. Use Bundy's tubing experience on your tubing problems. For the complete Bundyweld story, call, write, or wire us at any time: Bundy Tubing Company, Detroit 14, Mich.



Bundyweld, double-walled from a single copper-plated steel strip, is metallurgically bonded through 360° of wall contact. It is lightweight, uniformly smooth and easily fabricated . . . has remarkably high bursting and fatigue strengths. Sizes up to 56° O.D.

BUNDY® TUBING COMPANY

DETROIT 14, MICH. . WINCHESTER, KY. . HOMETOWN, PA.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING, AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, ITALY, JAPAN.

September 14, 1961

Circle 373 on Page 19

287

MIXER

Wagner "Stand-up" motors pack plenty of power

Here's plenty of power for equipment requiring normal thrust vertically mounted motors. Wagner® Vertical Solid Shaft Motors provide power without problems for your pumps, mixers, agitators, axial fans, centrifuges, presses . . . anywhere you need a vertical motor drive with plenty of stamina.

Wagner Vertical Solid Shaft Motors are end-mounted, squirrel-cage type with a NEMA Type "P" base that is precision-machined to mate with equipment. Smooth running under cyclic loads, they won't labor or stall . . .

conform with NEMA Design B motor requirements in all respects. Their cast iron construction is simple and rugged . . . stands off corrosion . . . stands up to rough, tough treatment. Here are motors that are designed to give you economical, maintenance-free service the year 'round, indoors or out.

Wagner "Stand-up" Motors are available in ratings of 1 hp and larger with nominal full load speeds of 3500, 1750, 1160, or 870 rpm, and can be supplied with a completely dripproof enclosure, a standard totally enclosed fan-cooled enclosure, or an explosion-proof TEFC enclosure. Whatever the horsepower, whatever the enclosure, whatever the application, one thing is sure . . . these compact, power packages get the job done. For all the reasons why, check with the Wagner Sales Engineer in the Wagner branch nearest you, or write us for Bulletin MU-249.

Branches and Distributors in all Principal Cities

Washer Electric Corporation

6404 PLYMOUTH AVENUE, ST. LOUIS 33, MO., U.S.A. Manufacturers of LOCKHEED* Products

Wagner Vertical Solid Shaft Motors provide the power for Smith & Loveless sewage pumping stations.









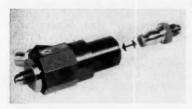
can be up to 8 ft. Using a powertype photocell with high infrared sensitivity, and with a filter to minimize the effect of ambient visible light, system operates a dc relay without amplifiers. Relay of the system is a plastic-cased, plug-in unit having two sets of single-pole, single-throw load contacts, one normally open and the other normally closed. Contacts are rated 8 amp, 115 v ac, noninductive. Farmer Electric Products Co. Inc., 2300 Washington St., Newton Lower Falls, Mass.

Circle 696 on Page 19

Disconnect Coupling

is squib-operated unit for pressures to 4000 psi

Squib-operated disconnect coupling, designed for remote operation, incorporates an internal fluid coupling qualified to MIL-C-25427. Model shown, which is reusable, is equipped with 1/4-in. standard flared tube fittings. It can be connected or disconnected manually.



Modifications are available for service in nitrogen gas as well as in a variety of fluids. Operating pressure rating is 4000 psi. Pyronetics, 11973 E. Slauson, Santa Fe Springs, Calif.

Circle 697 on Page 19

Silicone-Rubber Insulation

is color-striped

Color striped silicone-rubber insulation for multiconductor and single

Circle 375 on Page 19→

LONG LIFE, THOMSON "Snap-In"

-BEARINGS of smooth, tough DuPont NYLON



Low Cost FLANGED Nyliner



Low Cost SLEEVE Nyliner



Low Cost DOUBLE-FLANGE Nyliner

COST LESS to BUY COST LESS to INSTALL & ELIMINATE LUBRICATION

Additional Benefits:

- · CLOSE FIT
- . LONGER LIFE . EASIEY INSTALLED
- LESS SERVICING
- SELF-RETAINING
- RESIST CORROSION
 NON-CONTAMINATING
- . LOW FRICTION
- · RESIST POUNDOUT
- . NO FRICTION OXIDATION . MINIMUM SPACE
- DAMP VIBRATION
- . OPERATE IN LIQUIDS
- . INSTANTLY REPLACEABLE
- RESIST ABRASION
- SILENT OPERATION
- . LIGHTEST WEIGHT
- . REDUCED WEAR

Engineered to Solve Problems . . . Improve Products . . . Reduce Costs!

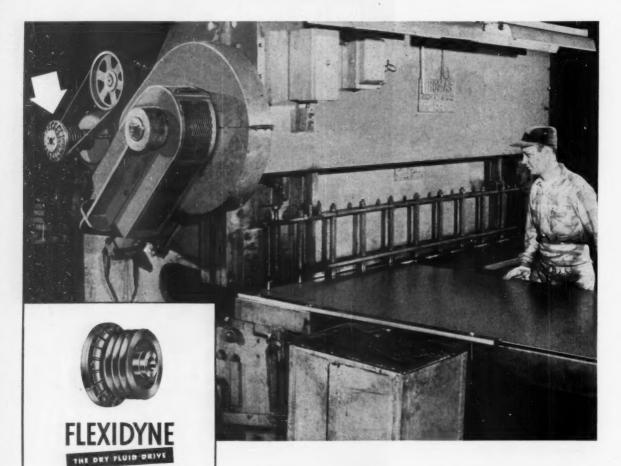
NYLINER Bearings are a highly engineered thin liner of DyPont Nylon, designed to bring bearing users the many benefits of Nylon as a bearing material by solving most of the limitations surrounding its use. The compensation gap principle assures maintenance of diametral tolerances for precision applications.

Seven Standard Types available from stock. Write for literature and name of your local representative who stocks NYLINER Bearings for immediate shipment.

THOMSON INDUSTRIES, Inc.

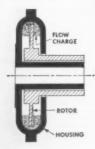
DEPT. 4. MANHASSET, NEW YORK

-Manufacturers of BALL BUSHINGS . . . the Ball Bearing for Linear Motions and 60 CASE . . . Hardened & Ground Steel Shafting



The "fluid" in Flexidyne is heat treated steel shot. A measured amount, called the flow charge, is contained in the housing which is keyed to the motor shaft. When the motor is started centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor which transmits power to the load.

After the starting period of slippage between housing and rotor the two become locked together and achieve full load speed, operating without slip and at 100% efficiency.



Look, Folks...No Strain!

- saves motors and V-belts!

- cuts starting current draw!

Introduce Flexidyne into your drive system and your stubborn loads take off smoothly, without the necessity of oversize motors or costly controls. Flexidyne provides the equivalent of a "no load" start, reduces maintenance, protects motors against shock or overload, and operates at 100% efficiency at full load speed!

Across the nation—on shears, mixers, agitators, blowers, chippers, ball mills, cranes, conveyors, cotton cards, jaw crushers, everywhere—thousands of Flexidynes are performing brilliantly. Here is the new and better way to start loads smoothly!

Flexidyne is available from stock in 8 drive sizes and 10 coupling sizes for capacities to 1000 hp. Ask your Dodge Distributor, or write us for complete technical bulletin.

Dodge Manufacturing Corporation, 3300 Union St., Mishawaka, Indiana





CALL THE TRANSMISSIONEER, your local Dodge Distributor. Look under "Dodge Transmissioneer" in the *white* pages of your phone book. Factory trained by Dodge, he can give you valuable assistance.

hook-up wire and cable is now available. It permits the use of smaller wires in multiconductor cables and results in lightweight, flexible, reduced-diameter cable. Smaller silicone-insulated wires also eliminate braids which are subject to fraying and moisture absorption. Wire is available in AWG sizes 24 through 10. Boston Insulated Wire & Cable Co., 65 Bay St., Boston 25, Mass.

Circle 698 on Page 19

Servo Gear Boxes

provide ratios from 2:1 to 625:1



Line of precision servo gear boxes offers over 720 variable units. Providing even, exact binary ratios from 2:1 to 625:1, units are available for use in servo, computer, and research applications, Furnished in light, medium, and heavy-duty models, boxes provide for a wide variation in design and mounting arrangements. Backlash, measured at output shaft with input shaft locked, is held to a maximum of 30 min. Maximum rated output torque ranges from 250 oz-in, in the 1/8-in. shaft series, to 500 oz-in. in the 1/4-in. shaft series. All units are available with slip clutch, antibacklash gears, or both. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle 699 on Page 19

Latching Relay

in one or two-coil subminiature units

Subminiature magnetic latching relay, Type LF, is a two-coil model which provides complete control of the latching operation within the relay itself, making for simplified circuitry in a small space. Single-





Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

ZENITH TIMERS



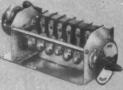
Program Clocks



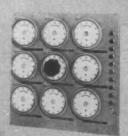
Time Delay Timers



Automatic Reset Timers



Multi-Circuit Cycle Timers



Master Programmers

FAST DELIVERY... on a Wide Range of Special and Standard Timing Controls

Now, choose the right timer for any control requirement from Zenith's versatile line. Save time and avoid delay. Get prompt engineering and delivery on specials . . . immediate delivery on standard controls.

DEPENDABLE—Take advantage of Zenith's experience in engineering and manufacturing quality controls and timing devices for over 35 years.

- Program Clocks
- Time Switches
- Interval Timers
- Time Delay Timers
- Automatic Reset Timers
- Multi-Circuit Cycle Timers
- Percentage Timers
- Impulse Timers

Our catalog A-17 also includes

- Automatic transfer switches engineered to assure continuity of power
- Magnetic contactors ruggedly designed for reliable power switching

Write for your copy of Bulletin A-17 today. See classified phone directory under Electrical Equipment for local representative.





ZENITH ELECTRIC CO.

152 WEST WALTON STREET . CHICAGO 10, ILLINOIS

Telephone: Michigan 2-3322 . Cable Zenelec



coil model can be used with existing circuits where outside control is provided. Single-coil models are sensitive to approximately 75 mw with an operating time of 8 millisec at 25 C. Sensitivity of the two-coil models is 150 mw per coil with an operating time of 5 millisec at 25 C. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.

Circle 700 on Page 19

Miniature Bearings

have tolerances equivalent to ABEC-5

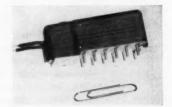
Value Precision miniature bearings are for gear heads, gear trains, motors, potentiometers, clutches, and other commercial applications that require high-quality miniature bearings. Tolerances are equivalent to ABEC-5. Specifications for the line include standard radial-play range of 0.0002 to 0.0005 in., MIL-L-6085 lubricant, and capsule packaging. Barden Corp., Danbury, Conn.

Circle 701 on Page 19

Squib-Actuated Switches

have open and closed circuits in a single unit

Six circuits in any open or closed combination are energized simultaneously by a series of squib-actuated, miniaturized switches available for general electronic, military, and industrial applications. Easy replaceability of the switches makes them suitable as protective devices against overload in expensive ma-



INDUSTRIAL RETAINING RING PRICES REDUCED UP TO 51%



Series 1000, Series 3000 and Series 3100 Industrial Retaining Ring prices—in quantities up to 100,000—have been greatly reduced.

Thanks to modern, efficient production methods you can now get these Industrial Retaining Rings—either prestacked or bulk packed—at new, low prices . . . and pay less for pre-stacked rings than you have been paying for bulk packed. Reductions apply to standard materials and finishes.

Use this coupon to send for your new, revised IRR Price List.

INDUSTRIAL RETAINING RING COMPANY

	copy of the new 1961 IRR Price List - 6 1M to have your representative call.
Name	Title
Company	
Address	



Originators of modern retaining ring dispensing

INDUSTRIAL RETAINING RING COMPANY

57 Cordier Street, Irvington 11, New Jersey

chinery or equipment. Weighing only $1\frac{1}{2}$ oz, switches have both open and closed circuits in a single unit. Switches are approximately 2 in. long, 1 in. high, and 9/16 in. wide. They operate normally within a temperature range of -65 to +160 F, and withstand centrifugal acceleration of 1000g. Minimum capacity of the switch contacts is 10 amp dc and resistance of each pair of closed contacts is less than 0.025 ohm. Dial Service & Mfg. Inc., 1741 Rockwell Ave., Cleveland, Ohio.

Circle 702 on Page 19

Bellows, Bellows Assemblies

for gas or liquid transmission lines

Metal bellows and bellows assemblies, supported and unsupported, are individually designed for use as pressure seals, flexible joints, or vibration dampeners in gas or liquid-transmission lines subject to high pressure or vacuum and tempera-



ture extremes. Available in sizes from 1 to 12 in. ID, bellows are stainless steel and other metals, in either development or production quantities. Avica Corp., Box 180, Newport, R. I.

Circle 703 on Page 19

Rustproofing Oil

light-duty oil protects steel surfaces

Entek RPO-12 is a thin, organic liquid which gives protection to steel surfaces. It provides temporary rustproofing to parts in process between manufacturing operations, to parts in storage, or to parts during shipment. Any rust-producing moisture remaining on iron and

steel after cleaning, blackening, or other wet-processing is replaced by a thin, rust-inhibiting film. Oil has very low viscosity and drains freely from work upon withdrawal. It can be applied by dipping, spraying, brushing, or tumbling. Oil resists moist acid and alkaline fumes from pickling and aluminum etching solutions; it is not recommended for protection against outdoor exposure. Enthone Inc., New Haven, Conn.

Circle 704 on Page 19

Speed Reducers

provide reductions of up to 3600:1

Reductions of up to 3600:1 have been attained by mounting a worm and gear set at a 90-deg angle to another set. Together with enclosed housing, double-reduction speed reducer is available in a wide selection of ratios between 25:1 and 3600:1. Seven sizes have torque capacities between 22,700 and 145,000 lb-in. Primary and secondary reduction housings are parallel to one another. High-speed housing is cooled to





OEM Guide to Electric Heaters

How to select the exact heating element to meet your product requirements

Here's condensed information from General Electric to help you get the most economical heater for your products.



CARTRIDGE

• Applications—Efficient, self-contained heaters, for use singly to provide a "spot" of heat, or grouped

to heat larger surfaces. Perfected for use in process machinery and for localized heating requiring close thermal control: dies, platens, molds, extrusion and injection barrels, gluepots, compound pots.

Features—Durable nickel-chromium re-

• Features—Durable nickel-chromium resistance wire packed in insulation and sheathed in metal tube.

• Ratings—30 to 2800 watts—Sheath temperatures: brass (750F); nickel-silver (1000F); chrome-steel (1200F)—Over-all lengths: 1½ in. to 2 ft.—Diameters: 3% in. to 1.293 in.—115v to 230v.



IMMERSION HEATERS

• Applications—Offer clean, economical method of heating various liquids in tanks, kettles, jack-

ets and other containers. Suitable for immersion in water, oil, alkaline solutions, nickel, copper, chrome, plating solutions, mild sulphuric acid baths and salt baths.

- Features—Long life—Easily installed— Easily controlled—Sealed terminals—Excellent insulation and heat conduction.
- Ratings—Both through-the-side and over-the-side models available—Sheath materials: copper, nickel-silver, stainless steel, Inconel and lead—115v to 230v—Wide variety of models from 650 to 10,000 watts.



FIN TUBULAR HEATERS

• Applications— Especially suited to forced-convection air heating applications, such as air ducts with

forced-air circulation, blower-type electric unit heaters, car heaters, recirculating ovens, industrial processes requiring heated air blasts for drying, baking, testing or pre-heating.

- Features—Large radiating surface per unit length—Fins sturdily attached by brazing—Quick heat transfer—Nonoxidizing rust-resistant finish—Durable construction.
- Ratings—Wide variety of shapes available—Sheath temperature: steel (850F)
 —Watts: up to 100 per linear inch.



TUBULAR

Applications—Applicable to practically every low-temperature (1500F or lower) requirement,

whether heating liquids, air, soft metals, or metal surfaces. Typical applications: ovens, ducts, platens, pipes, space heaters.

- Features—High-quality resistance wire, insulated in metal tubing—Heaters bent to conform to almost any shape, cast into metal, located in drilled holes, grooves, or spaced away from surfaces.
- Ratings—Standard ratings, 500 to 5000 watts; special ratings available—Sheath materials: steel (750F); nickel-silver (1000F); stainless and Inconel (1500F); copper (212F in water).



STRIP

• Applications—Designed for direct clamping to surfaces. Typical applications: process machinery,

drying ovens, matrix scorchers, warming tables, glue tables, water baths, drying cabinets, pipelines, incubators, valve and pump houses, telephone switchboards, roll heating, packaging machinery.

- Features—Uniform heat distribution— Corrosion-resistant sheath materials— Easy to install—Moderate cost—Uniformity.
- Ratings—Provided with offset terminals at one end or terminals at each end—Sheath materials: Aluminized-steel (1000F); Chromized-steel (1200F).



METAL-MELTING HEATERS AND POTS

• Applications—Feature cast-in immersion heaters for melting lead, babbitt, tin, solder, type metal

solder, type metal and similar metals up to 950F. Applications: dip soldering of subassemblies, railway and repair shops, electric service shops, printing plants, manufacturing plants, remelting metals.

- Features—Heat generated right in metal for quick heating, low radiation losses—Heater easily replaced without interrupting production—Reliable, safe, economical—Can be tied in with automatic temperature control.
- Ratings—Standard melting pots— Wt. 50 to 2000 lbs—Watts: 750 to 30,000.



OVEN

• Applications—Designed for such applications as baking, japan, foundry cores, drying low-tempera-

drying, low-temperature drawing ovens, and for general air heating applications in which there is free movement of air by convection. Heaters used in recirculating type ovens for core baking, paint drying, tempering, air heating in ducts, placement inside oven.

- Features—Easily mounted on side walls of oven or in ducts—Wide range in heater ratings and combinations of heaters.
- Ratings—Temperatures: Two models available: 750F-1000F, and up to 1200F.



VANE-TYPE HEATERS

• Applications—Used for air and surface heating applications: baseboard heaters, pipe heating, platen

heating, valve and pump heating, drying cabinets and ovens, process machinery, compound tanks.

- Features—Rugged tubular construction resists mechanical shock and vibration— Large, 1¾ in. wide radiating surface— Low heat density: 25 watts per linear in. of vane; 14.3 watts per sq. in. of heater surface—Can be easily formed—Convenient mounting holes.
- Relings—Variety of models from 500 to 2500 watts—115 to 230 volts—Over-all lengths: 24 to 104 inches—Maximum operating temperature 750F.



FREE New Catalog of General Electric Calrod* Industrial Heaters and Devices

- Complete information on these and many other G-E heaters and devices and control.
- Easy-to-use application data—New charts, tables, and guides make it easy to select just the right product for any application.

For your new catalog, write today to Section 757-02, General Electric Company, Schenectady 5, N. Y. Ask for GEC-1005.
*Rea. Trade-mark of General Electric Co.





fast delivery on custom requirements SPUR • HERRINGBONE • HELICAL

Horsburgh & Scott specializes in fast production of quality industrial gearing . . .

Gears engineered to meet custom requirements in a wide range, from small to large sizes.

Speed Reducers produced in standard types and special drives for fast custom delivery.

Send your specifications, or let our technical staff make recommendations.

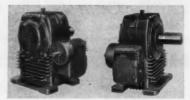
Write for Catalog FLB-60



The HORSBURGH & SCOTT CO.

5112 Hamilton Avenue • Cleveland 14, Ohio

Manufacturers of Gears and Speed Reducers for over 75 years



AGMA standards by an aluminum or plastic fan. Large oil-bath capacities and deep fins on both housings keep operating temperatures below a 100-deg rise above ambient. Both reductions share a common oil bath. Cleveland Worm & Gear Div., Eaton Mfg. Co., 3300 E. 80th St., Cleveland 4. Ohio.

Circle 705 on Page 19

Solid Tantalum Capacitors

in low-capacitance ratings

Addition of 28 new low-capacitance ratings, 0.0047 through 0.82 mf brings the number of standard capacitance-voltage-tolerance ratings of tan-TI-cap electrolytic capacitors to over 250. Packaged in Type SCM case, 0.125 by 0.250 in., capacitors are available in 20 or 35 v dc ratings. They are offered in 10 and 20 per cent tolerances. Units meet mechanical and electrical requirements of MIL-C-26655A. Semiconductor-Components Div., Texas Instruments Inc., P. O. Box 5012, Dallas 22, Tex.

Circle 706 on Page 19

Tube Axial Fan

is $2\frac{1}{4}$ in, long by 3 in, diam

Model F234-1 tube axial fan is available for application in electronic spot cooling or chassis cooling in missile, avionics, and ground-support programs. Fan has an input of triple or single-phase, 400 cycle, with an output of 100 cfm at 0.25-in. static pressure at 55,000 ft





Some folks just buy our pushbuttons

We sell pushbuttons like this by the thousands.

They are working at more start-stop, fast-slow, up-down control jobs than you can shake a stick at.

We sell our starters, relays, brakes and other electrical control units by the piece, too. Fact is, you can spot the Clark nameplate somewhere in most any industrial plant.

Other customers want us to do the job from A to Z. So, our Clark staff has become top-rated in electrical control for automation.

We create control for the steel mill lines that handle super-tonnage. We direct the machinery that processes rubber. We keep production lines moving in the auto body plants.

This is why we say:

Whether it's a simple electrical component or a super-duper production line control, please, just push the button marked "Clark."

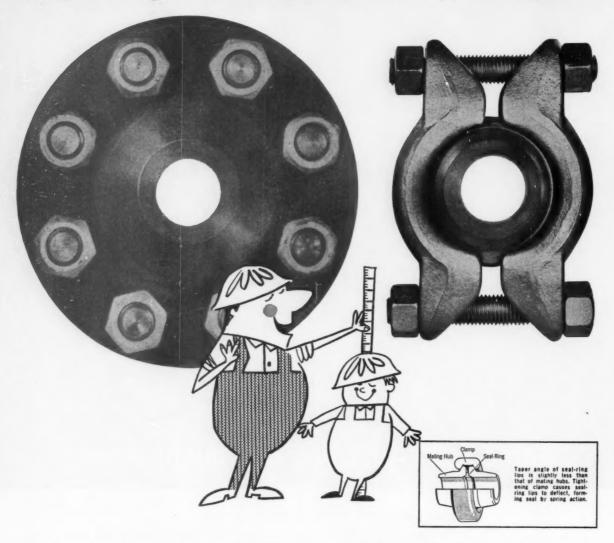


CONTROLLER COMPANY

MAIN PLANT: CLEVELAND, 10 · WESTERN PLANT: LOS ANGELES, 58 IN CANADA: CANADIAN CONTROLLERS, LIMITED, TORONTO, ONTARIO

Circle 383 on Page 19

Grayloc Pipe Connections Save 1/3 the Space



GRAYLOC® pipe connections are up to one-third smaller than flanged connections with comparable maximum pressure ratings. They save wasted space cut unit weight and assembly time drastically.

An all steel assembly, GRAYLOC employs a pressure aided seal that can be assembled or disconnected in minutes. The heart of the assembly - the seal ring - is completely reusable.

Although GRAYLOC connections are manufactured in standard stock sizes from 1" to 30", special sizes for special applications are available on request. Corrosion resistant metals can be provided on short notice.

You can use GRAYLOC connections in your piping system. They'll save you maintenance and assembly time, space and money. To learn how, write for the new GRAYLOC catalog.



GRAYLOC SALES DIVISION

GRAY Tool Company

P.O. BOX 2291 · HOUSTON 1, TEXAS · RIverside 7-1240

or 58 cfm at 1.0-in. static pressure at sea level. Weight is 0.72 lb, and size is $2\frac{1}{4}$ in, long by 3 in. diam at mounting rings. Mounting is by servo-type clamping rings at both ends for either panel or duct mounting. Electro Products Div., Western Gear Corp., 132 W. Colorado St., Pasadena, Calif.

Circle 707 on Page 19

Miniature Lamp Assembly

is low-voltage, low-current indicator

Miniature Logic Lite combines a waterproof panel-seal lamp holder, with a built-in resistor network, and a replaceable neon cartridge lamp with an O-ring seal, Unit requires 0.625 in. behind the panel,



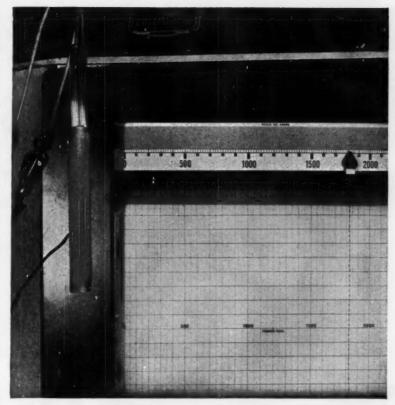
and is used as a low-voltage, low-current indicator in transistor circuitry. A seal at the lamp and a seal behind the panel combine to make the unit completely water-tight. Potted resistor network is hermetically sealed and will operate under conditions of 95 per cent relative humidity. A variety of lens colors and shapes is available. Unit meets MIL-L-3661-A, for use where suitable driving circuitry is available. Eldema Corp., 1805 Belcroft Ave., El Monte, Calif.

Circle 708 on Page 19

Vinyl-Coated Glass Cloth

in widths of 36 and 50 in. for high-temperature use

Vinyl-coated glass cloth is available for high-temperature applications in aircraft construction, welding curtains, and in other industrial and maintenance fields. Coverlight-V material is available in widths of 36 and 50 in., weights from 5 to 20 oz, in white and other (Please turn to Page 302)



WATLOW'S FIREROD OPERATES 720 HOURS IN OPEN AIR AT 1800°F.

No other cartridge heater can match this!

Watlow's Fireron® Cartridge Heater has outperformed every other heater on the market in rigidly controlled laboratory tests.

At a sheath temperature of 1800° F., a ½" o.d. FIREROD 2¼" long operated for 720 continuous hours rated at 90 watts per square inch. The unit was still operating satisfactorily at the end of this test while competitive so-called "high watts density" heaters had burned out. Under these conditions, standard cartridge heaters, manufactured

on the techniques used before the introduction of the Firerop, burned out in minutes.

Make your own comparison test. FIRERODS will save for you in three ways: Longer life, fewer replacements, and less space needed for required wattage. You can get FIRERODS, best by test, with deliveries of two weeks or less. Write for Firerod Bulletin 367.

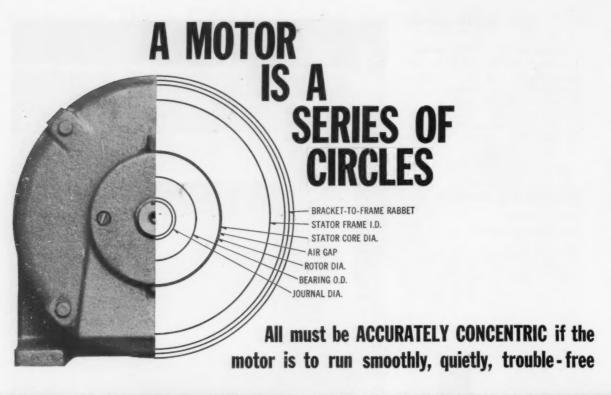


WATLOW

ELECTRIC MANUFACTURING COMPANY

1384 Ferguson Avenue / St. Louis 14, Missouri

6109





CONCENTRICITY of Elliott C-W Motors begins with the bracket-to-frame fit, the reference for all subsequent "circles." Bearing bore and shaft bore are precisely centered within this accurate diameter.



TOLERANCE of 0.0007 in. for the bearing bore is checked by an air gage after finishing in a precision lathe. Master jig assures accurate positioning of bearing, essential to uniform air gap.

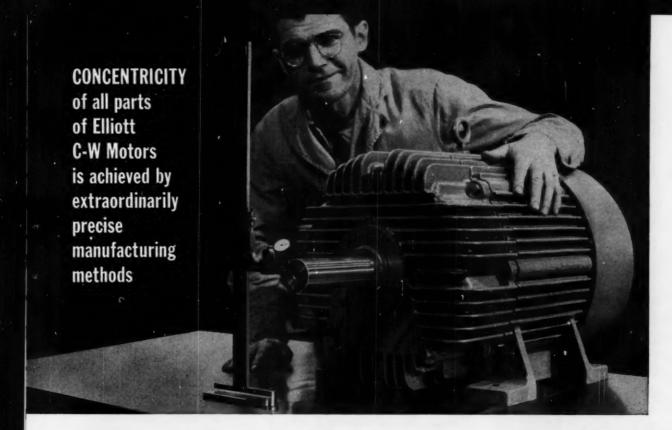
Elliott Crocker-Wheeler integral-hp a-c and d-c motors—from smallest to largest—are offered in all conventional enclosures and modifications; with insulation to suit the application, including pays epoxy insulation, for use where conditions are most severe.

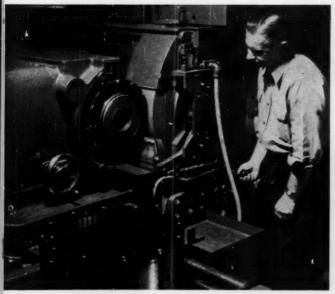


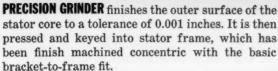
T GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES - GENERATORS - MOTORS - COMPRESSORS - TURBOCHARGERS - EJECTORS - STRAINERS - TUBE CLEANERS







Key manufacturing operations employed in maintaining the required close tolerances are described more completely in an interesting brochure, The Fine Art of Building Better Motors. We will be very glad to send you a copy.





DUPLICATING the basic bracket-to-frame fit, a jig accurately positions the wound stator for finishing the inside core diameter by a "fly cutter," which corrects for all accumulated tolerances and assures precise concentricity.

	M
ELLIOTT COMPANY, Advertising Departm	
Please send a copy Motors to:	of The Fine Art of Building Better
Name	Position
Company	

(Continued from Page 299)

colors. Vulcan Div., Reeves Brothers Inc., 1071 Avenue of the Americas, New York 18, N. Y.

Circle 709 on Page 19

Electronic Timer

is accurate to 0.005 sec

Type 940 electronic timer is a transistorized, general-purpose unit combining compactness, high load capacity, long life, switching circuit versatility, and precision of control. Full-scale time ranges are 0.1, 1, 10, and 100 sec, with three models for choice of use as an interval



timer, time-delay relay, or cycling timer. Repeat accuracy is 1 per cent of full scale on all units. No warm-up time is required, since no electronic tubes are used. Load contacts are double-make double-break, rated 25 amp, 120 v ac resistive. Power required is 115 or 220 v, 60 cycles. Unit is accurate to 0.005 sec. Cramer Div., Giannini Controls Corp., Centerbrook, Conn.

Circle 710 on Page 19

Fiber-Plastic Material

for temperatures from -40 to +200 F

Fibrite is a plastic consisting of hard vulcanized fiber with a bonded covering of clear plastic film. Combination enhances physical and high dielectric characteristics of fiber with increased flexural strength, improved flatness and appearance, and lower moisture absorption. Plastic film also has high dielectric strength, is resistant to solvents and grease, has a temperature service range from -40 to +200 F, and can be heat-sealed to itself. Material is particularly suited to large

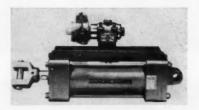
parts and thicknesses of 3/32 in. and over in applications where impact strength, moisture, or arc resistance are required. Spaulding Fibre Co. Inc., 310 Wheeler St., Tonawanda, N. Y.

Circle 711 on Page 19

Air Motor

has valve mounted on top of cylinder

Jockey air motor has an integral valve - on - cylinder arrangement which seats the valve directly on the manifold. Design frees both ends of the cylinders for use, making possible double-rod-end operation. Unit is adaptable to every type of air-motor operation. It can be mounted in a number of ways, including swivel, front





CURVED VANES
SCOOP UP MORE AIR
-- provide high capacity

 provide high capacity with slower speeds and less wear Four curved vanes scoop up large valumes of air—provide 2 to 3 times more air space. Mounted on easy-action hinges to assure perfect contact with cylinder walls by centrifugal force. Vanes and cylinders made of durable cast iron (no composition). Hone themselves to hard, glassy smoothness to assure leak-proof seal and reduce frictional wear. Negligible wear is automatically taken up by rotating vanes.



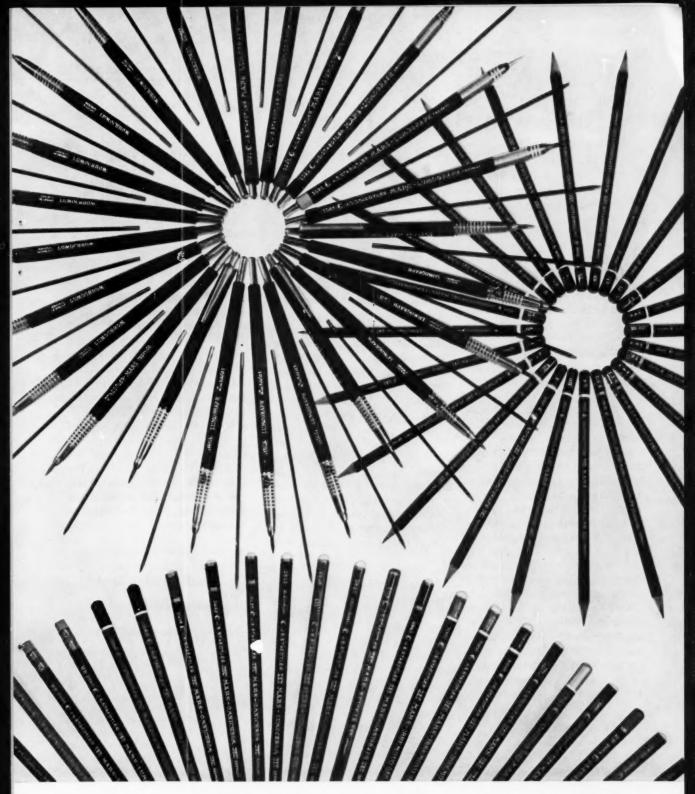
Write for new catalog showing construction, types, sizes and specifications, plus Application Book containing many "how-to-do-it" blueprints.

LEIMAN AIR PUMPS

Leiman Air Pumps maintain new-pump efficiency and fully-rated vacuum or pressure for the life of your equipment, with little or no maintenance or repair. Fewer moving parts—no gaskets or packing—no composition vanes to wear out or renew. Pulseless airflow—every pump tested. Many models and sizes to meet your needs. Over 70 years' air engineering at your service on any design or application.

LEIMAN BROS., INC., 158 Christie St., Newark 5, N. J.

Established 1889



ALL MARS - ALL TOPS

.... all imported from West Germany, made to meet the highest standards of professionals.

the pencil that's as good as it looks

MARS

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

Mars products are available at better engineering and drafting material suppliers everywhere. HACKENSACK, NEW JERSEY

Here are tips to help you achieve packing-fluid compatibility!

The efficiency, safety and ultimate cost of a hydraulic system is largely dependent on the compatibility of its packings and fluid medium . . . how well they do or do not work together.

Mineral Oils

The above is frequently overlooked when a plant switches from one type of fluid to another. Take mineral oils, for example. Three general types are used in hydraulics, and are classified according to their aniline points: high, medium and low.

If, through error, a high aniline oil is used where low aniline oils are specified, rubber seals in the system would shrink and harden. Conversely, "high aniline" rubber seals will swell and soften in low aniline hydraulic oils. Leakage or equipment failure is the result.

To complicate the picture further, mineral oils made to the same specification by different oil manufacturers, using different crudes, will vary in aniline point to the degree that they may cause synthetic rubber seals to either shrink or swell.

Even among the various types of synthetic rubber used for hydraulic seals, the reactions to mineral oils vary. Buna S and Butyl seals, for example, will disintegrate in mineral oil while Buna N, Neoprene, Viton and Thiokol polymers work very well.

Fire-Resistant Fluids

In many hydraulic systems, mineral oils are being replaced by modern, synthetic fluids which eliminate fire hazards without affecting hydraulic efficiency.

Three types of fire-resistant fluids are in wide usage and each type requires a *compatible* packing.

The three basic types of synthetic fluids with recommended and maximum recommended operating temperatures are shown in the box.

Туре	Recommended Temperature	Maximum Recommended Temperature		
Phosphate Ester	+130°F.	+180°F.		
Water-Glycol	120°	150°		
Emulsion water-oil	120°	150°		

Phosphate Ester fluids and mineral oils have a directly opposite effect on the same rubber seals. Butyl packings which fail miserably in mineral oils, work beautifully with straight Phosphate Ester while Buna N, which works well in mineral oils, is unsuitable for Phosphate Ester. For this reason, changing a system from mineral oil to Phosphate Ester requires a complete and careful flushing and cleaning as well as a switch in packing materials, if elastomer packings are used.

For use with these fluids, homogeneous packings should be of Butyl, fabricated packings of Butyl and duck or asbestos and leather packings should be either Wax or Thiokol impregnated.

Water-Glycol fluids are generally compatible with both Buna N and Butyl seals, and with duck or asbestos. However, they do attack leather fibers. Water-Glycols have a pH of 8.5 to 10.5 and leather fibers start to disintegrate at a pH over 8.0

Because of this pH condition, leather packings are not recommended for use with Water-Glycols. Homogeneous packings should be of Buna N and fabricated packings of either asbestos or duck and Buna N.

Emulsion type fluids react much the same as mineral oils do with rubber and leather. In homogeneous and fabricated packings, use Buna N; in leather, use a filler of wax or Thiokol. Never use Emulsion fluids with Butyl.

A Simple Solution

As complex as the subject appears, packing-fluid compatibility in hydraulic systems can be determined with very little trouble. Houghton Packing-Fluid Compatibility Tables will instantly tell you which packings work best with the various types of fluids in general use.

Better yet, Houghton is in a unique position to give you completely unbiased answers to your hydraulic packing-fluid problems, for Houghton is the only manufacturer who offers you a complete line of both packings and fluids for industrial hydraulic systems.

FREE! Packing-Fluid Compatibility Tables



For your copy of Houghton's Packing-Fluid Compatibility Table, or for help on any hydraulic packing or fluid problem, call your Houghton representative or write: E.F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Houghton

INDUSTRY'S PARTNER IN PRODUCTION

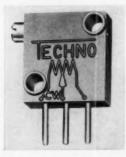
flange, foot, or clevis. It is available with single or double solenoids, momentary and maintained constant, in 1½, 2, 3, and 4-in. diam. Air Control Div., Lehigh Inc., Easton, Pa.

Circle 712 on Page 19

Trimming Potentiometer

has resistance range of 10 to 50,000 ohms

New trimming potentiometer is $\frac{3}{8}$ in. square and weighs $\frac{3}{4}$ gram. It has a variable resistance range from 10 to 50,000 ohms at a power rating of 1 w at 50 C. Operating temperature is 170 C. Component is available for circuit-board mount-



ing with top adjustment; circuitboard mounting with side adjustment; and lead-wire mounting. Techno-Components Corp., 18232 Parthenia St., Northridge, Calif.

Circle 713 on Page 19

Machine Drives

for fast stop-start cycles

Vari-Power machine drives for startstop cycling of production machinery and machine tools provide kinetic energy to meet momentary peakload requirements up to ten times their average load ratings. Drives include a compact axial air-gap motor and an integral clutch-brake coupling. Within the motor a high-inertia, constantly spinning rotor achieves a flywheel effect to store kinetic energy. Upon engagement of the clutch and release of the brake. top speed is reached by the output shaft almost instantaneously. Coasting is virtually eliminated through automatic clamping of the output shaft and its driven load by the brake, Drives have horsepower ratings of 1/3 to 7/12, with 1200, 1800,











Acme backs its quality Power Transmission Products with the best engineering service available in the industry. Even on short notice, Acme has its Engineers available to put their years of experience and technical knowledge to work in helping you solve a design, installation or any other chain drive problem you may have.

Acme has built its reputation on providing customers dependable service *before*, *during* and *after* the sale.

Wherever you are, whatever your problem, there's an Acme Engineer as close as your telephone, ready and willing to lend his assistance just for the asking. When your drive problems require service, call Acme.



Write Dept. 6-N, for new ill. 100 page catalog with engineering section.



RELIABLE CHAIN DRIVES FOR ALL INDUSTRIES

ROLLER CHAINS, SPROCKETS, CONVEYOR CHAINS, FLEXIBLE COUPLINGS, ATTACHMENTS. (Special and Standard)



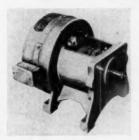
Upsetting of the hexagonal section in the center of this adjusting screw cut finished cost 28% compared to that hogged from hexagonal stock. The finished forging is stronger, too...upsetting increases strength by directioning the metal grain flow to match the shape of the part.

Check your products for parts that might be upset forged . . . then call -



When its a vital part, better make it FORGED





or 3600 rpm. Ferguson Machine Co., 7818 Maplewood Industrial Ct., St. Louis 17, Mo.

Circle 714 on Page 19

Divider-Combiner Valve

for pressures to 3000 psi

For use where two hydraulic actuators are required to operate in unison, Model 1467 flow divider-combiner valve is available. Used as a divider, valve divides pump output (up to 40 gpm) into two equal flows. As a combiner, valve equalizes the return flows of two cylinders to equalize piston speeds. Besides equal division or combining, valve can be factory-calibrated to any unequal combination. One or both of the divided flows can be redivided with additional valves to synchronize



multiple elements. Valve is available with one 1-in. and two $\frac{3}{4}$ -in. NPTF ports. It is recommended for pressures to 3000 psi. Waterman Hydraulics Corp., 725 Custer Ave., Evanston, Ill.

Circle 715 on Page 19

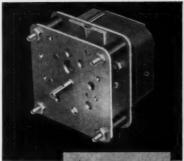
High-Voltage Rectifier

miniature unit gives peak inverse voltage to 3 kv

For voltage-multiplying circuits, subminiature high-voltage rectifying device is available in a diodesize package. Less than one-fourth as long as an ordinary paper clip, new encapsulation gives peak inHigh-quality, long-life
Barber-Colman geared motors
give you high torque,
positive starting...wide
selection to fit your needs











QUIET RUNNING
PRECISION-HOBBED GEARS
HIGH STARTING TORQUE
WIDE RANGE OF GEAR RATIOS
LONG-LIFE LUBRICATION
POROUS BRONZE OR BALL BEARINGS
OUALITY GUARANTEED

a-c small motors

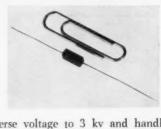
For longest life per dollar invested, put Barber-Colman geared motors into your product. Open and enclosed types . . . unidirectional, reversible, or synchronous. Highest quality construction . . . gears are accurately hobbed in our own plant on our own precision Barber-Colman hobbing machines. Motors are shaded pole type with torques up to 300 lb-in. and speed ranges from 1/6 revolutions per hour up to 1500 rpm. All are built for long, trouble-free service to help eliminate costly maintenance of your product. Yet cost per motor is surprisingly low.

THE WIDE LINE OF BARBER-COLMAN A-C MOTORS includes unidirectional, synchronous, and reversible types . . . with or without reduction gearing . . . open or enclosed. Stator and rotor sets also available. Write for quick reference file.

BARBER-COLMAN COMPANY

Dept. U, 1273 Rock St., Rockford, Illinois





verse voltage to 3 kv and handles a continuous operating current of 50 ma. Maximum power dissipation is 250 mw with a maximum ambient operating temperature of 150 C. North American Electronics Inc., 71 Linden St., West Lynn, Mass.

Circle 716 on Page 19

NEW WARD LEONARD, 4-POLE RELAY

more compact, more economical than ever ...for relay circuits up to 10 amps

Here's a new 4-pole, double-throw, power-handling relay that measures only 2-5/8" W x 3-1/8" H x 1-29/32" D and weighs only 11 ounces . . . only slightly larger than previous 3-pole relays, yet its contacts are rated up to 10 amps, non-inductive.

It's the new W/L NYLINE Bulletin 110 relay-another Ward Leonard relay you can stake your reputation on.

Look at these outstanding design features for long trouble-free life: Simplified nylon contact finger support to insure full electrical spacing and simplified contact placement . . . self-cleaning, self-aligning, silver contacts—for positive make and break with superior wiping action and follow . . . flexible silicone insulated leads connecting leaf-spring contact fingers and terminals . . . and many other big features.

You'll find complete information on the new 4-pole NYLINE relay (plus 2- and 3-pole models) in Ward Leonard Bulletin 110. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., 58 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

ENGINEERING DATA-4-POLE DT RELAY

CONTACT RATINGS

	D.C. A	mps.*	A.C. Amps.*		
Volts	N.O.	N.C.	N.O.	N.C.	
0-24	10	10	10	10	
25-125	1	1	10	10	
126-250			10	10	

COIL VOLTAGES: 6, 8, 10, 12, 24, 32, 48, 115, 230

AVG. COIL WATTS: 3.5 D.C.; 5.0 A.C

PICK-UP: 85% or less of rated coil voltage.

WEIGHT: 11 ounces.

DIMENSIONS: 2-5/8" W x 3-1/8" H x 1-29/32" D.

*Ratings are non-inductive.



RESULT-ENGINEERED CONTROLS

ELECTRIC CO MOUNT VERNON

RESISTORS . RHEOSTATS . RELAYS . CONTROLS . DIMMERS

Reinforced Plastic

for rocket applications

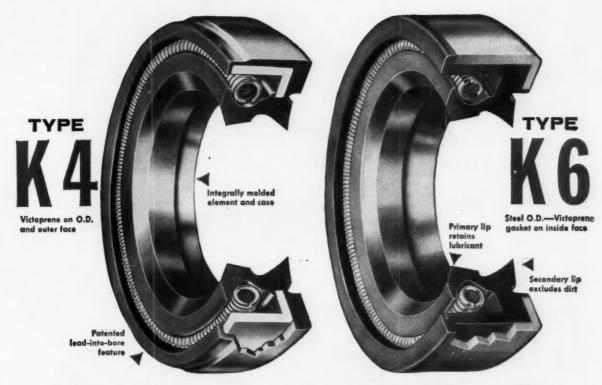
Tayloron PN nylon-base reinforced plastic features light weight and low thermal conductivity. Specifically developed for rocket applications, it can be used for components where temperatures exceed 4000 F for short periods of time. Made from nylon fabric impregnated with a proprietary high - temperature phenolic resin, material has excellent physical, thermal, and erosion characteristics and good dielectric strength. It is highly machinable, and exhibits high deflection under load. It is supplied in every form required for high-temperature applications. Advanced Materials Div., Taylor Fibre Co., Norristown, Pa. Circle 717 on Page 19

Fluid Filter

for hydraulic equipment has high capacity

Twin-Life high - capacity intake strainer/filter for hydraulic equipment is currently available in ca-





Proven design for compact dual-lip sealing

Two types...as narrow as 1/4 inch

In Type K4 Victoprene oil seal and its variant, Type K6, Victor offers a highly improved version of compound element shaft sealing. The two types accommodate varying installation and bore sealing needs, yet provide identical shaft sealing efficiency in the smallest housing space.

Check the design features. See how these seals can enhance your specifications for all types of machinery or automotive applications. You'll like their moderate price, too—and fast availability in all standard sizes! See your Victor Oil Seal Engineering Catalog No. 306.

DUAL SEALING SURFACES—Inner lip designed for maximum fluid retention. Outer lip excludes foreign matter or confines a secondary lubricant.

VICTOPRENE ELEMENT—Developed of improved Buna N synthetic rubber for balanced resistance to lubricants, heat, and age deterioration.

PRE-LUBRICATION CAVITY between lips provides for permanent lubrication on installation. Reduces frictional drag; extends seal life.

SPACE-SAVING NARROW WIDTH — Patented one-piece, integrally molded element and case construction permits most compact seal housing.

POSITIVE SPRING LOCATION—Molded groove in sealing element holds garter spring in proper place to keep uniform pressure on shaft.

POSITIVE BORE SEALING—Type K4 has bonded-to-case Victoprene on O.D. and outer face. Patented lead-in feature aligns seal for easy installation. Type K6, for metal-to-metal installations, has steel O.D., with integral gasket on inside face for bottom of bore seal.

TYPICAL APPLICATIONS—Wheel bearing seals on automotive vehicles, farm and road machinery, etc.; crankshaft; pinion; automotive transmission (rear extension housings); speed reducers; winches, etc.

K4 and K6 seals supplied without spring where it is not required

Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill. Canadian Plant: St. Thomas, Ont.

VICTOR

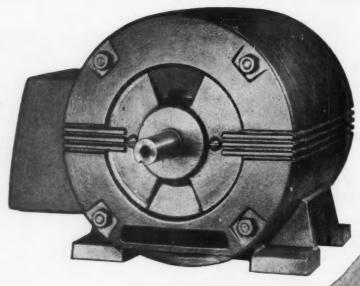
Sealing Products Exclusively

Victor Oil Seal Engineering Catalog No. 306, sent free on request. No designer should be without it.



OIL SEALS . GASKETS . PACKINGS . MECHANICAL SEALS

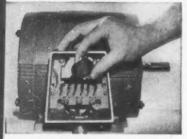
HOW WOULD YOU
DESIGN THE
TOUGHEST
POSSIBLE
GREASE SEAL?



FRANKLIN

DID THIS.

Protective devices stay where they belong—inside. It's the only polyphase motor with this built-in space.



Tough yet lightweight aluminum means lower shipping costs, easier assembly line handling, lower production costs.



Comes pre-wired to your specifications. Handiest terminal board design ever — just connect three line leads...that's all!



Pre-packed, double-shielded bearing, combined with a protective inner slinger forms a really "stubborn" system. Positive seal keeps grease in the bearing, bearing-destroying contaminants out.

NEW BEARING SYSTEM IS DOUBLE-SHIELDED TO KEEP GREASE IN. CONTAMINANTS OUT!

Bearings protected the Franklin way last longer, do away with maintenance headaches. A pre-packed, double-shielded bearing plus a slinger-type labyrinth seal keep grease in the bearing, assure you and your customers of longer motor life. An extra grease reservoir, sealed in the system, adds even more years of maintenance free performance. And contaminants that can cause bearing failure are positively locked out of the system. Stubborn? Like a rock! See the new Franklin integral made of lightweight aluminum and write for free color brochure.

Franklin Electric Co., Inc.



BLUFFTON, INDIANA

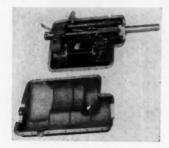
Circle 395 on Page 19

pacities of 5 to 10, 10 to 20, and 20 to 30 gpm. Filters are available in standard 100 mesh (140 micron) and in 60, 80, 150, and 200 mesh for filtering particles from 260 to 75 microns. Wire mesh is Monel; other parts are cadmium-plated steel. Michigan Wire Cloth Co., 2100 Howard St., Detroit 16, Mich.

Linear Actuator

has continuously adjustable stroke from 0 to 6 in.

Featuring positioning accuracy repeatable to within ±0.0025 in, without feedback, Model C402 actuator has a rated thrust of 500 lb tension and compression, with a maximum thrust of 1000 lb. Actuator also has a continuously adjustable stroke of 0 to 6 in, with an optional potentiometer for position indication, a capacitor start-and-run, and a reversible single-phase motor with



integral brake. Unit is entirely enclosed and all ball bearings and gears are lubricated for life. Electro-Mechanical Div., Lear Inc., 110 Ionia Ave. N.W., Grand Rapids 2, Mich.

Circle 719 on Page 19

Tantalum Capacitors

have increased ratings in same case size

Up to double the original capacitance values are now available in the same three basic case sizes of Type HP and PP electrolytic tantalum capacitors. Ratings range from 1.75 to 560 mf at de working voltages of 4 to 85 v for Type HP and 6 to 125 v for Type PP. Capacitors retain high reliability, frequency stability, negligible electrical leakage, and shock and vibration resistance. Ambient operating

MEEHANITE MEANS BETTER CASTINGS





SOLVE YOUR TOUGH CASTING PROBLEMS WITH MEEHANITE NODULAR

The excellent castability of Meehanite Nodular in combination with exceptional strength, ductility and wear resistance has led to its wide acceptance for intricate pressure castings and many other components which must withstand severe service conditions. The broad range of its utility is further enhanced by inherent production advantages resulting in a reduction of manufacturing costs.

Meehanite Nodular is available in a broad range of properties embracing all current Nodular specifications and including some unique new wear and heat resisting types. When you specify one of the S types of Meehanite Nodular, you can be sure of obtaining castings that live up to specified claims. Meehanite foundries have more than a quarter of a century of experience in handling the essential materials used to convert the graphite in cast iron from the flake form to the nodular which gives this family of metals its unique engineering properties. Meehanite patented quality controls assure uniform dependability regardless of how small or how large the casting.

For complete information about Meehanite Nodular, send for a free single copy of our eight page brochure (B-47-A). Write: Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.



MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.



Nylon has been proven in service as an outstanding bearing material because of built-in lubrication, ability to withstand abrasive and

corrosive environments, and mechanical strength. And MC* nylon,

newest of the nylon family, is more adaptable than any and most economical of all. Tubular bars, for example, cost less than other nylon formulations . . . even less than continuous cast bronze. Plate and rod sell at prices under com-

POLYPENCO MC nylon has pre-

mium properties similar to nylon

101 with outstanding wear life,

strength and resistance to defor-

mation under load. Typical applications: rollers, bearings, bush-

ings, gears, cams, forming de-

vices, wear plates, tooling and

general structural wear parts.

TUBULAR BAR: 2"-15" O.D.

SPECIAL SIZES AND SHAPES

SOLID ROD: 3"-24" O.D. LARGE PLATE: 1/4"-6" Thick

AVAILABILITIES

petitive nylons.

THESE MASSIVE **NEW NYLON** SHAPES CAN SAVE YOU MONEY!

IN BUSHINGS



Non-scarring work holder bushings for disc grinding roller bearings.

IN BACK-UP ROLLS



 $5^{\prime\prime}$ I.D. x $7^{\prime\prime}$ O.D. x $13^{\prime\prime}$ long back-up rolls for die cutting outline and patterns of paper place mats and lace doilies save \$2000 per machine in cost of rolls alone replacing Kraft paper rolls.

IN DRIVE ROLLERS



Support rollers for end grinding roller bearings.

*Trademark of The Polymer Corporation THE POLYMER CORPORATION



ON REQUEST

OF PENNSYLVANIA Reading, Pennsylvania Engineered Industrial Plastics

EXPORT: Polypenco, Inc., Reading, Pa.

STOCK SHAPES . MOLDING RESINS . SINTERED PARTS . WHIRLCLAD® COATINGS

temperature ranges remain -55 to +85 C for the Type PP and -55to +125 C for the Type HP. Tolerance for Grade 1 capacitors in both types is ±10 per cent in standard production. Rectifier - Capacitor Div., Fansteel Metallurgical Corp., North Chicago, Ill.

Circle 720 on Page 19

Control Valves

provides control for low-flow applications

Series 1400 valves for regulating the flow of small streams of air, water, steam, or chemical solutions include a lightweight, diaphragm-actuated model, a high-performance diaphragm model, a low-flow model, and two models having electric actuators. Valves are available in 1/2, 3/4, and 1-in. body sizes in a full



range of materials and body ratings with both screwed and flanged connections. Valve Div., Minneapolis-Honeywell Regulator Co., Fort Washington, Pa.

Circle 721 on Page 19

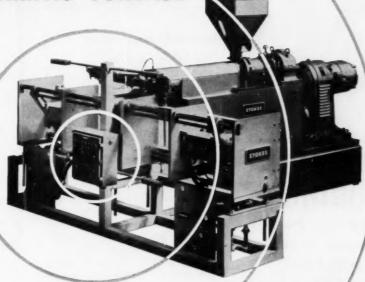
Printed-Circuit Connector

has 140 terminations divided into two sets of contacts

New printed-circuit connector provides two sets of twin receptacles to accommodate 1/16-in. printedcircuit boards. Connector has a total of 140 terminations divided into two sets of 38 and 32 contacts. Staggered, pierced terminations facilitate soldering operations. Contacts are beryllium-copper alloy, gold over silver plate; insulator material is diallyl phthalate per MIL-M-19833, Type GDI-30. Over-all length of the connector is 8.63 in. with 0.100 - in, contact spacing.

AN INDUSTRIAL TIMER

FOR AUTOMATIC CONTROL



At the heart of the new, high capacity STOKES BLOW MOLDER

The production of hollow plastic articles (containers, dispensers, etc.) has been boosted immeasurably with the development of "High Capacity Stokes Dual-Manifold Blow Molder".

And at the heart of the system is an Industrial Timer Corporation timing device to provide the precise control of each cycle of processing.

Wherever precise timing controls are required in industrial processes, or in equipment, Industrial Timer Corporation has the wide range of instruments, the wide experience in applying them, that assure the perfect answer to your problem.

If timing is of the essence . . . take the time to consult an Industrial Timer expert.

Phone or write us.



RUNNING TIME METERS



RECYCLING TIMERS



INTERVAL TIMERS



TIMER DELAY TIMERS



INDUSTRIAL TIMER CORPORATION

1404 McCarter Highway, Newark 4, New Jersey

Manufactured and sold in Canada by

SPERRY GYROSCOPE OTTAWA LIMITED • 3 Hamilton Ave., Ottowa, Canada • PA 8-4681

Circle 398 on Page 19

TUBING THAT KEEPS ITS TEMPER IN THE

TOUGHEST SPOTS



PRECISION TUBING

Made To Your Product Requirements . . . Sold At Regular Prices

The right temper in tubing can mean the difference in finished product quality. It should be varied to meet the job to be done.

Precision Tubing can be produced to meet your most exacting specifications from annealed to full hard. Continuous hydrogen atmosphere and combusted gas atmosphere bright annealing furnaces, scientifically controlled by advanced instrumentation assures the correct temper in every foot of tubing... locked in for the life of the tubing.

Precise temper is only one of the outstanding qualities of Precision Tubing. Accuracy, mirror-finishes, quick deliveries and regular mill prices are all offered in Precision Tubing... in copper, brass, bronze, nickel, nickel-alloy... sizes. 010" to 1.125" O.D. in all shapes. Get the full details, write for catalog to

PRECISION TUBE CO., INC. North Wales, Pa.



Circle 399 on Page 19

NEW PARTS AND MATERIALS



Breakdown voltage is 2200 v ac at sea level and current rating is 3 amp. Viking Industries Inc., 21343 Roscoe Blvd., Canoga Park, Calif.

Circle 722 on Page 19

Tungsten-Rhenium Alloys

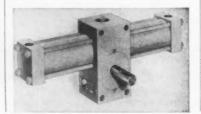
in expanded range of wire and strip sizes

Tungsten-26 per cent rhenium alloy is now furnished in wire sizes as fine as 0.0005 in, diam and in continuous lengths of over 2000 ft. Short lengths of strip of the same composition have also been produced in widths to 4 in, and thicknesses to 0.005 in, Principal properties of the wire and strip include high tensile strength at elevated temperatures, excellent electrical resistivity, and high melting point, approximately 5800 F. Hopkins Mfg. Co., 445 Lawton Ave., Detroit 8, Mich.

Rotary Actuator

in three models with 50 to 314 lb-in.

Air-Dex reversible rotary actuator is driven by air or hydraulic fluid pressure. Two opposing pistons move a gear rack over a pinion on a drive shaft for any desired rotation up to 350 deg. Rotation of the shaft can be stopped and reversed at any part of the cycle. Three models are offered, developing 50 to 314 lb-in. of torque with 100 psi pressure. Drive shaft is keyed for use with stock worm or spur gears or special cam or lever attachments. Functions include power steering, gate operation, indexing,



An
important
announcement
to users
and buyers
of miniature
and instrument
ball bearings

Caveat emptor

"There is hardly anything in the world that some men cannot make a little worse and sell a little cheaper and the people who consider price only are this man's lawful prey."

attributed to John Ruskin

The past three months have seen much activity in the miniature and instrument bearing field. Starting with MPB's introduction of MINA Bearings (ABEC 3 precision grade), the bearing user has been confronted more recently with fluctuating prices as well as the introduction of low-priced Class 5 bearings. These events have produced numerous questions from bearing users, chiefly concerned with how the price reductions affect performance and reliability, and puzzlement over the real need for a class 5 bearing with uncertain performance levels.

Prices for miniature and instrument bearings are based on the grade of precision (*ABEC tolerance specifications) and at the same time related to the quality controls needed to insure performance and reliability. Thus, to effectively specify bearings, the designer and buyer must understand exactly what price means both in terms of performance and grade of precision. There are five ABEC grades of precision for miniature bearings, as shown in the following table of tolerances:

*ABEC stands for Annular Bearing Engineers' Committee of the Anti-Friction Bearing Manufacturers Association (AFBMA)

ABEC TOLERANCES (in ten thousandths of an inch) - MINIATURE BEARINGS

	INNER RING			OUTER RING				ring width			
ABEC grade	bore +0	raceway runout with bore	face runout with bore	groove runout with face	width variation	o.d. +0	raceway runout with o.d.	face runout with o.d.	groove runout with face	width variation	tolerance +0
ABEC 1	-3	3	_		-	-4	6	-	-		-50
ABEC 3	-2	2	_	-	-	-3	4	_	_	-	-50
ABEC 5	-2	, 2	3	3	2	-2	2	3	3	2	-50
ABEC 7	-11/2	1	1	1	1	-2	2	11/2	2	1	-50
ABEC 9	-1	1 1/2	1/2	1/2	1/2	-1	1/2	1/2	1/2	1/2	-10

Two important facts are quite evident from this chart:

- There is only a small quantitative difference in the tolerances for the complete range of grades, and even a much smaller quantitative difference between, for example, ABEC 5 and ABEC 7.
- (2) Many factors extremely pertinent to bearing performance in precision instrument applications are not covered by ABEC specifications. The ABEC specs provide excellent definitions of dimensional accuracy, but this is all they define.

Some of the important factors affecting bearing performance not covered by ABEC standards are:

- 1. Material and heat treatment of bearing components,
- Material and neat treat
 Smoothness of operation.
- 3. Cleanliness, or freedom from contamination.
- 4. Noise and vibration level in operation.
- 5. Starting torque.
- 6. Running torque.
- 7. Conformity of race to ball (race curvature).
- 8. Surface finish of bearing components.
- 9. Load capacity.

In many applications one or more of these factors may be far more important to bearing performance than the dimensional accuracy (precision grade) of the bearing. The bearing user must recognize exactly what is, and what is not covered by ABEC specs; and he must coordinate this information with the operating requirements of his specific application. (An MPB bearing engineer will be glad to assist you).

MPB has established numerous standards for its bearings, in addition to the dimensional tolerances of the ABEC grades, which include special material and heat treatment specifications, special noise and vibration tests, surface finish tolerances and inspections, race curvature control, and extensive precautions to ensure cleanliness of the finished product.

From the viewpoint of value analysis, these controls which assure quality and performance can affect cost of the bearing as much or even more than operations required to achieve a certain grade of precision. Therefore, the sophisticated bearing buyer knows that any drastic cost reduction for a given precision grade bearing reflects omission or slackening of-controls.

This approach to marketing is not consistent with MPB's philosophy of producing a high quality product at a fair price. Therefore, we have established a production and pricing policy which results in fair-value unit costs without any sacrifice in inspection controls. MPB's new policy is as follows:

MPB will produce standard bearings in two precision grades — "Basic 7" and ABEC 3. "Basic 7" is MPB's designation for ABEC 7 bearings with .0002" (ABEC 5) tolerance on bore dimension to facilitate fitting practice. Standard ABEC 7 bore tolerance can be furnished at no extra cost. ABEC 3 bearings produced by MPB are designated by the tradename MINA Bearings. ABEC 5 grade bearings will be produced only on special order.

Features such as special radial play, special lubrication, packaging, coding, etc., formerly supplied at no additional cost (these costs were amortized over all bearing production), will now carry a price additive. Consequently, changes have been made in the price of basic bearings. Through this pricing plan every user is assured of highest bearing quality and reliability, but each customer pays for only those special requirements that he specifies. To most customers this plan will result in substantially better bearing prices.

You are cordially invited to send for MPB's new Engineering Catalog and new prices. The latter, too, are virtually miracles in miniaturization.

HORACE D. GREBERT, President

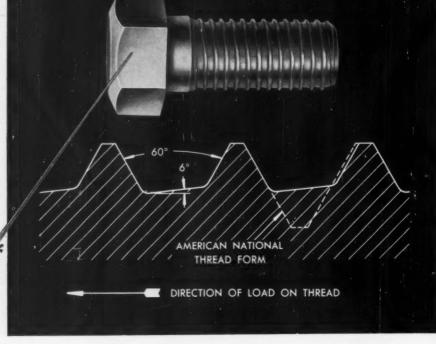
MPB

Helps you perform miracles in miniaturization

MINIATURE PRECISION BEARINGS, INC., PRECISION PARK, KEENE, N. H.

NAT'S quick facts about Fasteners...





Can **any** fastener

actually become tighter in service?

WELL, HARDLY. NOT JUST ANY FASTENER ...

But self-locking, extra-strength LOK-THRED® bolts, studs and screws do, and even after long service you can expect their breakaway removal torque to average about 70% higher than at installation.

Here's the reason. Just take a look at the LOK-THRED profile. Notice the extra-wide root? And its converging angle? It's held, strictly by design, to exactly 6 degrees.

Now, see what happens, as you drive any LOK-THRED fastener. It re-forms the metal of the receiving thread, squeezing out every void, and forming an intimate metal-to-metal contact. And each of the angled roots becomes a 6-degree tapered wedge, with the loading constantly pulling against it to make its anchorage even firmer.

That's why LOK-THRED fasteners actually do become tighter in service. They're self-sealing, too . . . fluids can't leak past them. And yet they're fully reusable...require no selective fits...can be used with ordinary tools.

Take our word for it, there are plenty of reasons* why LOK-THRED is superior for many kinds of fastening . . . and we'll be glad to help you develop any applications to your own products.

*They're all given in National's LOK-THRED booklet, with plenty of supporting data. Write for your copy.





The National Screw & Mfg. Company · Cleveland 4, Ohio

California Division, The National Screw & Mfg. Company • 3423 South Garfield Avenue, Los Angeles 22, California

tool positioning, and azimuth control. Mo-Bar Hydraulics Co., Crystal Lake, Ill.

Circle 724 on Page 19

Motor-Brake

has external manual release



L-60 Universal series 11/2 and 3 lbft torque brake is offered for direct shaft attachment to NEMA motor frames 56C, 66C, 182C, and 184C. Design permits use of standard NEMA-length shaft extension for hub mounting. Cover permits vertical, wall, or ceiling mount. Brake is electrically released and spring set. In the event of power failure, brake will hold load until power is restored. External release trip permits remote operation. Dings Brakes Inc., 4714 W. Electric Ave., Milwaukee 46, Wis.

Circle 725 on Page 19

Circuit Breaker

is trip-free unit

Series C-500 circuit breaker provides positive circuit protection. Electromagnetic circuit breaker weighs 2 oz. maximum and withstands 50g shock and extremes of vibration and temperature. Trip-free feature makes it impossible to maintain the contacts closed when unit is carrying



(Please turn to Page 320)

FOR ACCURA

Here are only four examples of the many ways to position accurately loads weighing as much as several hundred tons with Duff-Norton Worm Gear Jacks.



An application with two Duff-Norton Worm Gear Jacks mounted on swivel subbase and each lifting screw end fastened to hinged member by means of clevis and pin. Jacks may be motor driven or manually operated.



Four Duff-Norton Worm Gear Jacks connected in rectangular arrangement by Duff-Norton Mitre Gear Boxes, shafting and flexible couplings and driven by gear motor to raise metal sheets to press level.



Six Duff-Norton Worm Gear Jacks as used on pipe-cut-off and threading machines to adjust height of machine spindle to level of conveyor table to compensate for various sizes of pipe.

Platen pressure obtained positively and uniformly by two Duff-Norton Worm Gear Jacks with rotating screws.

There are eight standard models of these jacks-capacities range from 2 to 100 tons, with standard raises up to 24 inches.

For engineering drawings of standard jacks, mitre gear boxes and more examples of how Duff-Norton Worm Gear Jacks are used for accurate movement of loads, write for Bulletin AD-66a-V.

DUFF-NORTON COMPANY

Four Gateway Center, Pittsburgh 22, Pennsylvania The Canadian Duff-Norton Co., Ltd., Toronto 6, Ontario

DUFF-NORTON JACKS Ratchet . Screw

Hydraulic • Worm Gear



COFFING HOISTS Ratchet Lever • Air

Hand Chain • Electric

Designers think of R/M first for asbestos, rubber,

Poly-V "J" Light Duty Drive Gives You Design Advantages Never Before Possible

Most Revolutionary Drive for Small Sheaves, Short Centers, Compact Units

R/M POLY-V® "J" DRIVE is industry's newest and most revolutionary light-duty drive for small diameter sheaves, short centers and compact units. It utilizes a single parallel V-ribbed belt running on space-saving sheaves grooved to mate precisely with the belt ribs. Design advantages of Poly-V "J" add up to more dependable power in less drive space wherever balance and highly efficient, silent, vibration-free drive performance are required.

Advantages

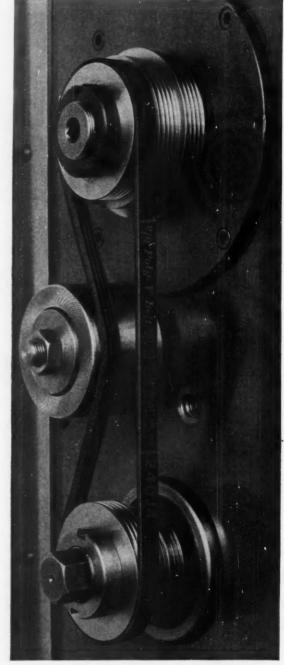
- Designed especially for small sheaves; considerably below V-belt range
- Silent, vibrationless, cool operation; homogeneous traction surface is spliceless, lapless
- No belt matching; a single belt cross section meets every need from 1/40 to 15 HP
- Delivers much more load in less space; permits more compact drive with smaller mounting clearances
- Exceptional flexibility; operates easily with midget motors
- Ideal for tandem, mule, ¼ turn or serpentine drives; with reverse bend idlers and for speeds up to 10,000 f.p.m.
- Minimum drive wear; assures longer belt and sheave life
- Absorbs shock; overload slip protection against machine damage
- Complete contact pressure; maintains groove shape
- Heat and Oil Resistant

Poly-V "J" has been proved for smooth, silent power service on a wide range of small machinery—home workshop, machine tools, wash machines, lawn mowers, household appliances, and for many types of industrial, commercial and scientific machines.

For medium and heavy duty drives, R/M Poly-V* is available in the larger "L" and "M" Sections. These 3 Poly-V Belts (J, L and M) will replace 8 V-belt size sections and cover a power range from 1/40 to 1700 HP. Wherever your design problems involve power transmission drives, V-belts, flat belts . . . rely on R/M products and engineering.



Write today for free booklet shown: full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N.J.



Poly-V"J" on Parker Majestic Grinder as standard equipment

sintered metal, and engineered plastic products

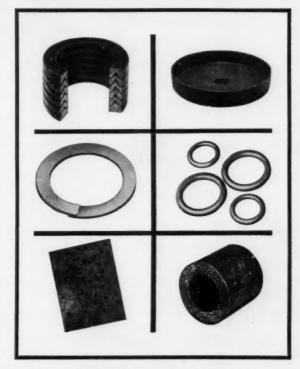
BOND FAILURES CAN BE PREVENTED! Here's how to stop 13 of them . . .

Here's how to stop 13 of them					
Type of Failure	Solution				
THERMOSETTING ADHESIVES					
Cohesive failure	Check film with solvent used in adhesive. If solvent softens the adhesive film or becomes tacky, this indicates insufficient cure. Make sure bond line time and temperature is used.				
Adhesive failure from metal	If metal surface has a white, clean appearance, check cleaning technique.				
 Adhesive failure from substrate other than metal 	Try prime coat of diluted adhesive, also check compatibility.				
Cellular areas in adhesive line	Increase pressure and/or adhesive.				
CONTACT ADHESIVES —room temperature setting					
Tacky film	If film should dry hard but remains tacky, the cause may be entrapped solvent or migration of plasticizer from one substrate.				
• Shiny areas	Poor contact, insufficient pressure or in- sufficient amount of cement.				
No bond	If heat reactivated type, adhesive was too cool at time of assembly or poor compatibility.				
 Failure in adhesive from metal 	Improper cleaning.				
From substrate other than metal	Incompatible or unclean surfaces.				
HOT MELT					
No bond	Incompatibility, adhesive too cool at time of assembly. Parts too cool at time of application of adhesive.				
EPOXY BASE ADHESIVES AND CASTING COMPOUNDS					
High exotherm	Mix lower volume and pour mixed material into shallow tray. Cool base and activator before mixing or use Metermixing equipment.				
Tacky film or casting	Improper base activator ratio, improper mix- ing of base and activator, improper cure. Check bond line temperature.				
Flexible casting or film of rigid adhesive or casting compound	Improper mixing of base and activator, Improper base and activator, Improper cure. Check bond line temperature.				

Bond failures can be prevented! Raybestos-Manhattan's adhesive experts also have solutions to less common causes of bond failures . . . based on more than 20 years' experience in the production of bonded assemblies and the manufacture of adhesives, coatings and sealers. Why not call on them today for the answers to your adhesive problems—no cost or obligation, naturally.



Get helpful engineering information on selecting, bonding and testing adhesives. Write today for your free copy of Bulletin No. 701. Adhesives Department, Raybestos-Manhattan, Inc., Bridgeport, Conn.



R/M CAPABILITY PRODUCES REINFORCED TEFLON PACKINGS

to lower friction, eliminate contaminating lubricants, resist corrosion and extrusion

Now you can get "Teflon" packings with the exact mechanical properties you require. R/M capability has developed a host of reinforced Teflon packings, one or more of which may meet your requirements.

Among these are Vee-Flex® rings, piston cups, gasket materials, and specially machined and molded products. Each is designed for a specific application—using the advantages of Teflon coupled with the advantages of other materials.

R/M's broad experience in design, compounding and manufacturing of mechanical packings and gasket materials is at your disposal. Send data on your specific application.

PACKINGS



Write for new catalog giving complete information about Reinforced Teflon Products and other R/M packing and gasket materials.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Fullerton, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada



(Continued from Page 317)

current that would normally trip the contacts to their open position. Breaker is available with auxiliary contacts to actuate remotely located panel lights or alarms. Voltage ratings are 50 v dc and 120 rms v, 60 or 400 cps. Current rating is 50 ma to 15 amp. Short, long, and instantaneous delays are available. Cambridge Div., Airpax Electronics Inc., Cambridge, Md.

Circle 726 on Page 19

Transistorized Timer

Uses timing network with no moving parts



Atcotrol Series 308 miniature transistorized timer provides time control for laboratory and industrial process. Extended life is assured through the use of a simple timing network which has no moving parts or tubes. Load-contact rating is 5 amp at 115 v ac noninductive. Power requirements: 115 v, 50/60 cycles; or 230 v, 50/60 cycles. Automatic Timing & Controls Inc., King of Prussia, Pa.

Circle 727 on Page 19

Stainless-Steel Cylinder

"throw-away" unit has 3/4-in. bore



New ¾-in. bore, stainless-steel body, "throw-away" type cylinder is available in single or double-acting types, with a choice of front nose, pivot, or double-end mount. Body is mirror-finish Type 304 stainless steel. Bimba Mfg. Co., 101 Main St., Monee, Ill.

Circle 728 on Page 19



Here's information you can use to increase speed and accuracy in high precision control and measuring equipment . . . 4 fact-filled pages on Holtzer Cabot's line of R-24 Servo Motors.

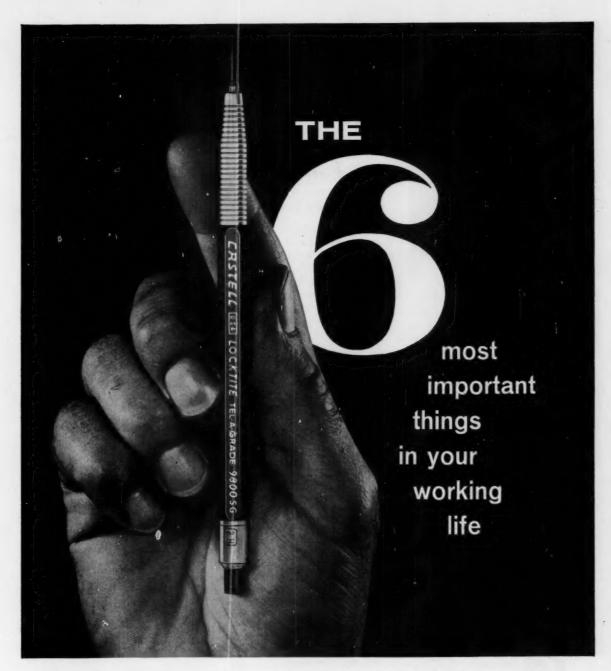
Contains 3 sets of speed-torque, performance curves: (1) For four different stator stackings with 115V on both windings. (2) For four different stackings with 115V on fixed winding and 200V on control winding. (3) For 0.7" of stator stacking with 115V on fixed winding and 200V, 100, and 50 on control winding. Gives additional data such as starting voltage, stall torque, rotor inertia, acceleration at stall, etc.

The R-24 Line has stator cores of 2.4" diam., available with stacking lengths of 0.5", 0.7", 1.0" and 1.4". Models with or without gear trains. Send for your free copy of Bulletin MO-3.7A. Write: Holtzer-Cabot Motor Division, 125 Amory Street, Boston 19, Massachusetts.



MOTOR DIVISION

National Pneumatic Co., Inc., Boston 19, Mass.



The 6 most important things in your working life are your five skilled fingers and your A.W.FABER #9800 SG LOCKTITE Tel-A-Grade Lead Holder.

LOCKTITE becomes a part of your creative process. The no-slip functional grip gives you smooth traction and practically banishes finger fatigue. Gun-rifled clutch holds the lead like the jaws of a bull dog. Unique indicator reveals the degree in use at a glance. Carries ironclad 2-year guarantee. A.W.FABER will replace the entire holder at no charge if any part wears out in normal

usage. Yes, you can buy cheaper lead holders, but can you afford to let pennies stand between you and your perfect working tools? Buy quality—buy LOCKTITE, call your dealer today.

Castell Drawing Leads #9030, are of the identical quality and grading as world-famous Castell wood pencil ■ Usable in all standard holders, but a perfect mate for Locktite ■ Draws perfectly on all surfaces, including Cronar and Mylar base films ■ Available in all degrees from 7B to 10H, and in a kaleidoscope of colors ■

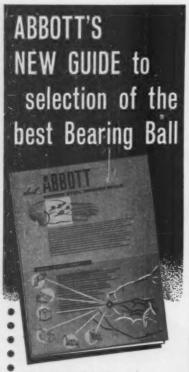


A.W.FABER-CASTELL Pencil Co., Inc., Newark 3, N. J.

Our Bicentennial year—1761-1961 200 years of uninterrupted manufacturing experience.



AW FABER CASTELL DRAWING LEAD 9030



New Abbott Bulletin AP-1 provides specifiers and buyers with up-to-the-minute information on widely adaptable, totally reliable Abbott bearing balls . . . carbon steel and bronze. Included is important new tabular data on conversion of old Abbott standard ball nomenclature to the new, simplified AFBMA* nomenclature.

Since 1909, Abbott has offered product designers a bearing ball of superior quality and performance . . . a bearing ball that has a deeper case, higher crushing strength, closer tolerance than balls in competitive lines. Bulletin AP-1 tells you why Abbott is the best. Send for your copy today. Anti-Friction Bearing Manufacturers Association.



	BOTT BALL
	E . HARTFORD 10. CONN.
Send copy of Bulle	din AP-1.
NAME	
TITLE	
COMPANY	
STREET	
СПУ	STATE

Circle 408 on Page 19

DEPARTMENT

EQUIPMENT

Calibrated Drawing Aid

new model has improved index window

Plastic, 12-in., combination triangle, T-square, and parallel ruler permits rapid drawing of vertical, horizontal, and parallel angular lines in automatically measured distances. Built-in roller allows smooth, easy movement up or down when drawing lines. Improved index window automatically indicates distance be-



tween lines, angular and horizontal, as close as 1/16 in. Lines can be spaced the same, or placed at varied distances apart. Vertical lines are made by placing ball point or pencil in any hole and rolling up or down. Circles and arcs can be scribed to a diameter of 22 in. Rol-Ruler Co., Riegelsville, Pa.

Circle 729 on Page 19

Automatic Oscilloscope

has all-solid-state circuitry and digital readout

Solid-state, 10-megacycle, fully automatic oscilloscope displays a perfectly sized and positioned picture of the waveform under test, regardless





HIGH-SENSITIVITY SWITCHING @ LOW UNIT COST

highly reliable low wattage relays from LIONEL

solder lugs or plug-in terminals for printed circuit boards

insulating bases and dust covers optional

TYPICAL UNIT

Rating: 50 milliwatts
Impedance: 2300 ohms
Pull-in current: 4.7 ma
Drop-out current: 1.0 ma
Electrical specifications
can be changed to suit
application.

Send for data on "4325 SERIES" RELAY Write Dept. 39-MR



LIONEL
ELECTRONICS DIVISION

Hillside, New Jersey

PRODUCT-DESIGN BRIEFS FROM DUREZ

- · Matte finish for molded parts
- Phenolic for blowers
- Fire-safe, bakable reinforced polyester



NORTON LABORATORIES, INC.

Want less gloss?

For years we've trumpeted the virtues of the high gloss that's characteristic of phenolic molded parts.

Gloss, however, is not always a plus. In certain precision instruments, gloss translates into glare. Sometimes, too, a consumer product can gain esthetically from the satiny look and feel of a matte finish.

One custom molder, Norton Laboratories, Inc., has developed a special process for putting matte finishes on compression-molded phenolic parts, as on the double-duty lamp handle-switch above. In some instances, the finish takes the place of a painting operation and so lowers cost.

The plastic molder now supplying this type finish is Norton Laboratories, Lockport, N. Y. We suggest that you write to them directly for quotations on plastic parts you need incorporating this finish.



Move air at low cost

Note the economy of design in this blower and duct assembly for an automatic washer-dryer. Why use more pieces when three will do?

Note, too, how economy begets economy. Very few assembly operations. Few rejects, because these phenolic parts can't get bent and won't warp. No balancing needed in the blower wheel, because con-

centricity is molded in. Wobble is much less than could be achieved at low cost in a metal wheel.

Phenolic is functionally right for airmoving jobs, especially if they also involve heat: a small hair dryer, a big circulating fan, or just about anything between. Inexpensive general-purpose molding compound serves adequately, as a rule: withstands moisture and mild corrosive atmos-

pheres; is unbothered by temperatures up to 300°F; even resists flame spread; operates for years without rattling, drumming.

Your molder of thermosetting plastics can probably help you achieve such economy, whether in a blower or some other part you're working on. To get more ideas on where and how to use phenolic molding compounds, send in the coupon, requesting Durez Bulletin D400.



The different polyester

Cutting across the currents and countercurrents of talk about reinforced polyester plastics are two incontrovertible facts:

- 1. You can get a polyester molding material that's inherently and permanently self-extinguishing.
- This same polyester can take a bakedon finish without surface craze.

Its name is Hetron.® The self-extinguishing trait does not come about as a result of diluting the plastic's strength with additives. It's there to begin with, in atoms of chlorine welded tightly into the resin molecule. That's why it lasts.

So much for chemistry. The craze resist-

ance takes longer to explain, but matcheddie molders know they can count on it for structural shapes that must undergo a 90minute bake at 350°F.

Superimpose these two truths on the other advantages of strong, lightweight polyester construction, and you can appreciate why Hetron is helping so many designers give shape to new ideas. This luggage pod for a jet airliner is one case in point. Others include 65-foot radomes, factory skylights, large boat hulls, outboard-motor shrouds, chemical ducts and vessels, transformer housings, heavy-duty switch-gear components.

If you'd like to know more about this versatile material, check the coupon for designer's Hetron data file.

For more information on Durez materials mentioned above, check here:

- ☐ Phenolic molding compounds (8-page Bulletin D400)
- "Durez Plastics News" (a review of current plastics applications, mailed bimonthly)
- ☐ Hetron polyester resin (data file and list of fabricators)

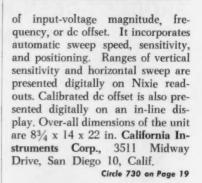
Check, clip and mail to us with your name, title and company address.

DUREZ PLASTICS DIVISION

509 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION





Pressure Transducer

measures in 0-50 to 0-500 psia range

Subminiature semiconductor pressure transducer measuring 1/4-in. diam utilizes semiconductor strainsensing elements arranged in a full Wheatstone bridge to convert pressure-induced strains into high-level output signals. Designated Type PO3BA5, transducer is applicable



to a wide range of uses, and is suitable for measurements in 0-50 to 0-500 psia range. High natural frequency resulting from the 1/4-in. diam flush diaphragm eliminates response to vibration encountered in most severe applications. Unit operates in a temperature range of -65 to +250 F, and has nonlinearity and hysteresis of ±1 per cent of full scale. Micro Systems Inc., 319 Agostino Rd., San Gabriel, Calif.

Circle 731 on Page 19

Diazo Print Developer

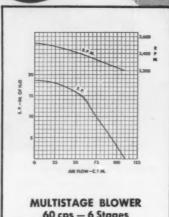
makes prints to 42 in. wide

Thermomatic diazo print developer features a heated roller which speeds up the action of the ammonia developer. It also produces completed development on black-line prints and sepias, and makes prints to 42 in. wide. Unit, used together



MULTI-STAGE BLOWER

60 cps or 400 cps 1 or 3 o To 440 Volts 10" O.D. by lengths up to 14" Ambient Range: -55° + 85° C **Commercial or Military**



60 cps — 6 Stages

When engineering specifications require continuous duty and quiet long life, Air Marine offers multistage blowers for low volume, higher pressure applications to 1 psi with air delivery to 100 CFM. Featured is long life with low noise. Where high pressure is required or on such vacuum applications as tape retention, the Air-Marine multistage blowers are the efficient answer.

> Our field engineers will gladly assist you in the selection and application of motors, blowers or fans.

Air Marine motors, blowers and fans have been designed and tested to meet the specifications of both the military and industry.

WRITE TODAY FOR OUR NEW CATALOG

air marine





Big volume of engineering prints? Put Ozalid's new Printmaster 900 to work. This new, heavy-duty whiteprinter is a workhorse for capacity, a thoroughbred for quality, a favorite for economy.

Fast! Top speeds up to 75 feet per minute. Versatile... processes any dry diazo material up to 42" wide without sticking. Develops both sides in one pass! Unique...new, sleeveless, scratch-proof developing and simplified control make it top performer in its price class.

Here, in truth, is a new concept in whiteprinting. New ideas, new designs from the leader in the industry that spell new efficiency, reliability, economy in engineering reproduction.

The coupon will bring you the facts on Ozalid's new "900". Facts that may save you thousands yearly. Mail it today.

OZALID®

Division of General Aniline & Film Corporation, Johnson City, New York REMEMBER, FOR PEAK EFFICIERGY, ALL GRALID WHITEPRINTERS WORK BEST WITH GRALID SENSITIZED MATERIALS

	mes A. Travis, Mgr., Marketing , Dept. 214 Johnson City, New Yorl
Please	send information on New Printmaster 900
Name_	
Firm_	
Addre	58
City	



with the Expeediter diazo printer, weighs only 30 lb and is designed for wall mounting. It can also be used as a desk model if desired. Rotolite Sales Corp., Stirling, N. J. Circle 732 on Page 19

Tracing Paper

has good reproduction transparency

Five Hundred tracing paper is a 100 per cent rag paper for engineering and drafting applications of strength and permanence. Paper has good reproduction transparency, is an excellent tracing medium which produces good blueprint and diazo re-

production copies. It has a finetoothed surface for use with pencil and ink for layout, sketch, drawing and tracing, and has good erasibility. Paper is available in standard roll lengths and widths, as well as in a variety of stock sheet sizes. Charles Bruning Co. Inc., 1800 W. Central Rd., Mt. Prospect, Ill.

Circle 733 on Page 19

Photoelectric Tachometers

cover speed range from 100 to 24,000 rpm

Three Safety Tach models are portable, self-contained, photoelectric tachometers providing fast, accurate speed measurement of both rotating and reciprocating machinery. Units utilize a photoelectric cell that responds to very small changes in illumination. As cell senses a light change caused by a marker on the moving object, it transmits a signal to a pulse-triggered computer which counts the rate at which the light changes, averages the rate per minute, and displays the result on a direct-reading dial. When cell is



aimed at any part of the path transcribed by a rotating marker and operate button is pressed, exact rate of speed is indicated on meter dial. Three models cover speed ranges from less than 100 to 24,000 rpm. Simonds Worden White Co., 1101 Negley Place, Dayton 7, Ohio.

Circle 734 on Page 19

Hand Pump

for high-pressure static testing

Model 50M hydraulic hand pump develops up to 50,000 psi and has maintained 65,000 psi continuously over a period of 100 hr. Designed primarily for high-pressure static testing, pump has a $\frac{3}{8}$ -in. piston

G-E LEXAN® POLYCARB



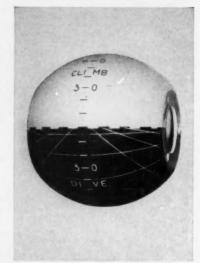
STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces.

(Superior Electric)



HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.

(Ungar Electric Tools)



DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of -65° to 300°Fl And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, latheturned and painted. (Lear, Inc.)

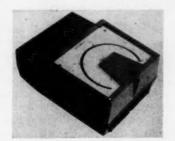
with a ¾-in. stroke, displacing 0.05 cu in. per cycle, and has self-sealing valves and release screw. Intake and pressure check valves are contained within the unit. Pump weighs 60 lb complete with 36-in. pump handle. Four holes tapped ¾-in. NC in the base block provide facilities for mounting. Unit can be furnished with or without gage. Wm. S. Pine Inc., 1635 E. 22nd St., Los Angeles 11, Calif.

Circle 735 on Page 19

Portable Instruments

have taut-band suspension

Portable ac and dc ammeters and voltmeters (shown) feature tautband suspension frictionless mecha-



nisms. Moving element of the suspension system is suspended between bands of high-strength metal ribbon which are supported on springs at each end. There is no wear between moving parts and maintenance is reduced. Since there are no pivots or jewels to crack and wear, units withstand rough handling. Scale lengths are 6 and 10½ in. respectively, with scale arcs of 100 and 240 deg. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 736 on Page 19

Drawing Point Sections

are available in sets

Rapidograph individual interchangeable drawing point sections are available in sets of one, three, and four, along with technical fountain pens. Sets are individually color-coded for quick identification of different point sizes. Point sections are nonclogging and easily cleaned. Each of the seven sizes from 00 to 4 has an airtight, individually attached, self-contained, reuseable ink cartridge which can be filled

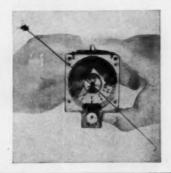
easily. Three assortments are available. Koh-I-Noor Inc., Bloomsbury, N. J.

Circle 737 on Page 19

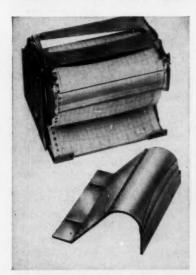
Torque Meter

computes relative torque value of ball bearings

Low-range, direct-reading Torqmeter provides a method for comparing the relative torque value of ball bearings. No. 781 unit delivers accurate readings involved in the rotating torques of miniature servo motors, gyros, and hair-



ONATE RESIN GOOD DIELECTRIC-



TRANSPARENCY of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides.

(The Foxboro Co.)



TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock . . . helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill. (Millers Falls Co.)

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic — amounting to 12-16 footpounds per inch of notch—and it usually emerges unscathed from encounters with such "merchandising stresses". It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us. General Electric, Chemical Materials Department, Section MD-91, Pittsfield, Mass.

LEXAN'

Polycarbonate Resin

GENERAL 🚳 ELECTRIC



Schulmerich electro-mechanical CARILLONIC BELL

systems . . .

Hansen
SYNCHRON
motors,
the "heart"
controlling
the split-second
timing of
Schulmerich
Carillonic
Bells



schulmerich carillons, inc., world's largest manufacturer of electro-mechanical carillons, uses Hansen SYNCHRON Timing Motors to drive the program clock governing the all-automatic operation of these precision, perfect-tone instruments. Clock programming is offered at 15-minute intervals, 24 hours a day, 7 days a week. Scheduled to play at specified times, exactly to the minute — there is no allowance for plus or minus variation.

HANSEN SYNCHRON TIMING MOTORS were selected as an integral part of Schulmerich Carillonic Bells because they outperformed all other motors tested. Carefully controlled testing was based on four specifications: (1) instantaneous starting, (2) no time loss or gain, (3) absence of malfunction, and, (4) reliable, continuous operation for periods of a year or more. Depending on installation, motors operate at either 110 or 220 volts — 50 or 60 cycles.

SEND TODAY for informative folder containing specifications and technical data on all Hansen SYNCHRON motors and clock movements.



HANSEN REPRESENTATIVES:
THE FROMM COMPANY
5150 W. Madison, Chicago, Illinois
H. C. JOHNSON AGENCIES, INC.
Rochester, N. Y. — Buffalo, N. Y. — Syracuse, N. Y.
Binghamton, N. Y. — Schenectady, N. Y.
ELECTRIC MOTOR ENGINEERING, INC.
Los Angeles, Calif. — (Olive 1-3220)
Oakland, California
WINSLOW ELECTRIC CO.
New York, N.Y. — Essex, Conn. (SOuth 7-8229)

Cleveland, Ohio

springs. Full-scale ranges are 1, 2, and 5 gm-cm, so that 3 per cent accurate readings are possible from 0.1 to 5 gm-cm at speeds to 10,000 rpm. Static and slow torques are read directly; torques over 100 rpm are read with the aid of a strobe light synchronized with the dial by a voltage "pip" coil mounted on the instrument. Unit is clear, molded plastic. Scale is 325 deg, 51/2 in. long. Power Instruments Inc., 7352 N. Lawndale Ave., Skokie, Ill.

Circle 738 on Page 19

Semiconductor Cooler Kit

contains complete units and modular components

Designers' kit contains representative types of semiconductor coolers, including natural-convection units and forced - convection modular packages. Kit contains both complete units and modular components. Complete technical data is supplied for each cooler model; handbook is included which outlines theory and practical techniques for temperature, power, and air-flow measurement. Delta-T Semiconductor Cooling Div., Wakefield, Mass

Circle 739 on Page 19

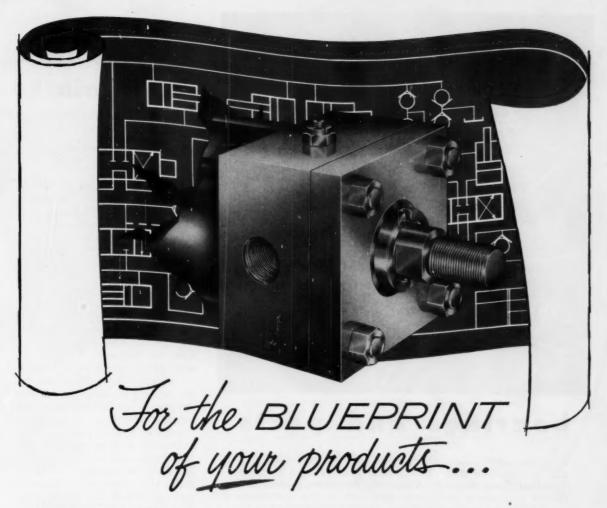
Copying Machine

combines diazo and photocopy units

Duet copying machine combines Copyflex diazo-process with a photocopy unit that copies anything, including difficult colored images and one or two-sided documents. Bottom section contains a dual-purpose exposure unit, convertible to either diazo or photocopy, and a diazoprocess unit with a maximum speed of 12 fpm. Upper section contains a photocopy processing unit, also with a 12 fpm speed. All three units are controlled by a single, graduated knob. In addition to photocopying, unit produces a translucent master from which low-cost copies can be made in the diazo section. Machine copies anything up to 11 in, wide by any length. Charles Bruning Co. Inc., 1800 Central Rd., Mount Prospect, Ill.

Circle 740 on Page 19

Philadelphia, Penn.



SPECIFY T=J CYLINDERS . . . FOR YOUR POWER DRIVE DESIGN • APPLICATION OR REPLACEMENT MAINTENANCE

From its blueprint stage to its maintenance engineering requirement sheet, your product will assure MORE power drive precision and service, if T-J cylinders are specified. T-J's complete line too, from the

Spacemaker to the new replaceable Squair Head, can be the answer to any power problem. Write or call The Tomkins-Johnson Company, 2425 W. Michigan Ave., Jackson, Michigan, today!





bearings and parts

Take the simple, sure, direct route to lower manufacturing and maintenance cost. Design into your product Bunting Standard Stock Bearings. You avoid inventory investment, delays, confusions, production problems by the immediate availability in small or large lots, from local distributors all over America, of hundreds of different stock sizes of completely finished cast bronze and sintered bronze bearings and bars, aluminum bars and Nylon shapes.

Special design bearings not obtainable from stock can be procured immediately at low cost from Bunting fully equipped machine shops in five industrial centers. The wide range of sizes of Bunting Stock Cast Bronze and Sintered Bronze Bearings makes the alteration of a stock item to a special bearing easy and economical. Bunting Cast Bronze, Sintered Bronze, Alumbars and Nylon shapes provide the materials for special requirements which cannot be made from stock bearings. Your local Bunting Distributor can arrange for such work.

A large staff of bearing engineers in the field stands ready to assist in the use of these Bunting stock products and in the designing of bearings or components for extraordinary applications. Two big, modern plants assure ample production capacity at all times for bearings and parts made from all modern metals and materials.

See Bunting's complete catalog, Sweets Product Design File 11C/BU or ask for Bunting's General Catalog, Form 158; Nylon Catalog, Form 32; Technical Handbook on Bunting Nylon, Form 33; The Techniclogy of Bunting Aluminum, Form 46; Engineering Handbook of Powder Metallurgy, Form 1; Bunting Machine Shop Service, Form 4.

The BUNTING Brass and Bronze Company
TOLEDO 1, OHIO
BRANCHES IN PRINCIPAL CITIES

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST DRONZE, SINTERED METALS, ALUMINUM ALLOYS AND MYLON

Professional Viewpoints

... who's the oddball? ...

To the Editor:

Your editorial of July 20, "Who's the Oddball?" raises in me an old urge to join in the campaign. For a number of years I have been acutely aware of the problems associated with the conversion of metric and English units and have several times thanked the powers that be that units of time are universal throughout the world. It certainly will be advantageous to all industries in the United States to start converting to metric units as soon as possible, as the longer we wait the more difficult the change becomes. Ultimately, with world markets becoming more accessible through improvements in communication and traveling time, it will be necessary for survival to make products whose parts, such as nuts and bolts, are readily procured in local markets to reduce the problems of maintenance. We showed the beginnings of this need when the United States and Britain standardized on a unified thread series. This was a wartime necessity, but now standardization becomes a peace-time neces-

Many thanks for calling the current congressional activity to our attention, I am anxious to help whenever I can to urge the adoption of metric standards in the English-speaking countries.

A. M. Stelle Mechanical Engineer Calabasas, Calif.

To the Editor:

Your editorial was read with deep interest. It coincided with a recent discussion that we had in our location. We were making some calculations that required the use of the gas constant and, even though it represents a common factor, a different value exists when used by a chemical engineer in his analysis or a mechanical engineer in his



TO FIND OUT: write for the brand-new Centrifugal Pump Catalog — Bulletin 130. Here are all the models — including useful engineering data.

For a complete review of positive displacement pumps for non-lubricating fluids, write for Bulletin 220. Eastern Bulletin 400 is your guide to a broad line of midget-centrifugal pumps and stirrers for the laboratory.



PUMPS

hydraulic motors • gear pumps
positive displacement pumps • aircraft pumps

Circle 417 on Page 19



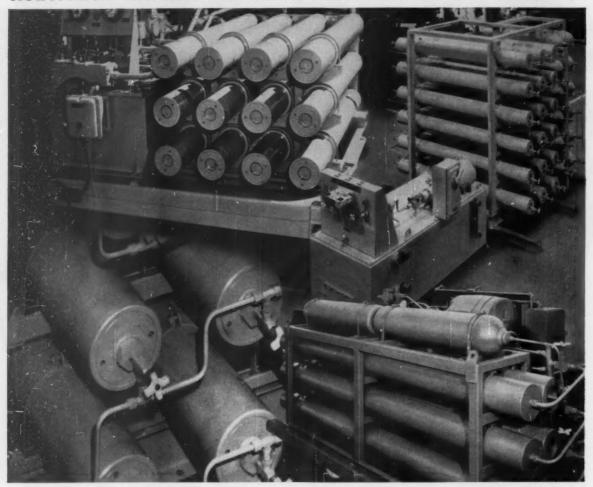








Now...more new accumulators from AMERICAN BOSCH!



AMERICAN BOSCH ACCUMULATORS are tailored to fit the job!

Now—American Bosch offers the most complete line of piston-type accumulators on the market! Sizes range from less than a quarter pint to twenty gallons. Models are available for a variety of pressures in both steel and aluminum—in many diameters, lengths and capacities to handle any job.

American Bosch accumulators are designed

and manufactured to meet the most rigid requirements. They combine many features to provide the utmost in performance and reliability.

When you specify accumulators for hydraulic systems—call for AMERICAN BOSCH ACCUMU-LATORS! Details are included in folder AC 110-02-2. Write for a copy and the name of your nearest distributor.

AMERICAN BOSCH ARMA CORPORATION

Commercial Sales Division . Springfield, Massachusetts









ACCUMULATORS FOR INDUSTRIAL, MARINE AND MOBILE APPLICATIONS

8269

analysis. About the same time, I received a temperature scale reference chart in which there is a cross reference between Kelvin, Centigrade, Fahrenheit, and Rankine temperatures. I recall that in college a fair amount of time and effort was spent in understanding the relationship between measuring systems where the time could have well been spent in fruitful engineering learning.

All of this has promoted a thought that our engineering effort is diluted considerably in an attempt to maintain a relationship between different ways of measuring and recording technical data. Other foreign countries-Russia, in particularcan concentrate within the metric system and thus avoid a continual translation between the various systems that exist in this country. With the minute accuracies that must exist in some designs such as the guidance systems of missiles, the translation between constants and measuring methods could throw in possibilities of errors that would not exist with a single system such as using metric units. A high degree of concentration can be put into technical analysis with the avoidance of whether the right values and units are being used. The effect of changing to the metric system would be tremendous and yet the overall advantage to us in the technical fields would outweigh the inconveniences experienced temporarily. I believe your editorial is very timely and would like to see formed a strong, active group to push forward the use of the metric system. Possibly the place to start would be in colleges and universities where the basic knowledge and groundwork are developed.

R. W. NEWELL
Manager
Heating Equipment Engineering
Air Conditioning Dept.
General Electric Co.
Trenton, N. J.

To the Editor:

Some 60 years ago when I was learning the metric system I could not understand why we did not adopt this system. I think I know why. Fear existed then about the



To belp you in designing machinery-

68 PAGES of engineering data

Here's a technical manual that will help you in selecting herringbone, helical and spur gears for industrial applications. Data compiled by Farrel engineers are based on forty years of experience in designing and manufacturing gears and gear units.

Nomenclature, formulas for determining dimensions, procedure for calculating horsepower ratings and example calculations are clearly outlined. Gears for special use such as in rolling mills and kilns, and for pump rotors are discussed in detail.

The most comprehensive book of its type ever published, it is concise and easy to use. Where possible, formulas have been simplified to reduce the calculations required.

Your copy will be sent without charge. Write today on your company letterhead.

FARREL-BIRMINGHAM COMPANY, INC.

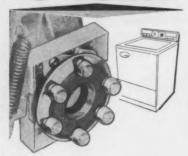
344 Vulcan Street, Buffalo 7, N. Y.
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Akron, Chicago, Minneapolis,
Los Angeles, Salt Lake City, Tulsa, Houston, Atlanta
European Office: Piazza della Republica 32, Milano, Italy



FB-1225

SYNPRO-TEX Speed Detectors Control

"G" FORCE



Pats. & Pats. Pend.

In one of the many and varied applications of TORQ speed detecting devices, a single SYNPRO-TEX speed detecting governor is used in a washerdrier appliance to . . . (1) reduce vibration by balancing clothes load. (2) Provide more thoroughly dried clothes. (3) Reduce wrinkling. The SYNPRO-TEX governor automatically cuts out the motor above 1G, switches it back on below 1G for approximately 20 cycles.

SYNPRO-TEX governors are "frictionless", snap-acting, centrifugal switches . . . actuated by speed only, accurate to 0.25% at speeds from 0 to more than 15,000 rpm, for over 1,500,000 cycles of uniform operation. TORQ governors can detect speeds dependably and economically on anything from rotating rat-traps to guided missiles. What's your problem?

Control of rotational speed for ballistic accuracy. Protection and control of components. Ask for Bull.



GAS BURNERS
Fuel control for safety
in starting and operation. Blower protection. Ask for Bull. 265.
GAS ENGINE



Automatic switching of cranking cycle. Overspeed protection, Ask for Bull. 264.

These uses illustrate a few of the many ways to increase operating reliability or reduce costs with TORQ speed detecting control.



26 West Monroe Street Bedford, Ohio Phone: BEdford 2-4100

Circle 420 on Page 19

PROFESSIONAL VIEWPOINTS

great cost of changing from one system to another. The degree of fear has been on the increase. Now, our rising generation fears that they will not be properly taken care of during their life span and want to be sure that they will have nothing to bother them until they are laid away.

Do our so-called "big men" ever think of the waste they permit to take place under their own eyes and do nothing about it? Just compare the waste that goes on each day in the many things in which we are involved, compared to savings that would eventually accrue if we did switch to the metric system. There are domestic problems and foreign or world-wide problems that would be dealt with more efficiently.

We do not get something for nothing; we must work for it. We are quite ready to junk some things by clouding our thoughts with the word "Progress." For example, even a moment's thought makes us realize that automobiles can be built to last longer and even be more efficient than those we buy; yet we go blindly on and are ready to throw labor to the winds and at the same time say it is too costly to spend money on a project that will net a return—the adoption of the metric system.

Wm. H. Thompson Chatham, N. J.

To the Editor:

Your editorial in the issue of July 20 ends with the question, "What do you think?" May I bias my opinion on the fact that I had my formal education in Europe, had ten years design experience there and have now worked here for seven years. The transition to a system based on the length of a grain of oats, the width of a thumb, and the distance from your or my nose to your or my middle finger was not easy. A reasonable length of time is about three months. With a plus tolerance of eternity! The eternity of looking up figures like: 1 oz in. = 0.005208333 lb ft, or No. 20 copper wire = 0.031961 in.

The eternity of, when dealing with any foreign country, having





HIGH PRESSURE Hydraulic Cylinders

Get smoother, more precise power; ruggedly built, interchangeable; 2000 psi (3000 psi non-shock); 12 bore sizes— $1\frac{1}{6}$ " thru 12"; get Catalog 117.



Save money, save space; boost 30 psi line air to 3000 psi hydraulic power with no added power consumption, no maintenance; see

Catalog 116.

FREE Engineering Service Phone or Write Today

The G-P Manufacturing Corp.

A BASSETT COMPANY 30201 Aurora Road • Cleveland 39, Ohio

FROM MIDGETS TO GIANTS,



One Source for All Sheet Metal Fastening Needs

PEM nuts are standard in thin metal fastening. The responsibility of this leadership has required that PENN ENGINEERING & MANUFACTURING CORP. supply a complete line of their self-clinching fasteners "the captive threads for production fastening" so that they meet every size and every requirement of industry.

The great variety of PEM Fasteners leaves no doubt that whatever your fastening problem, PEM can serve it from stock. Size, type, metal, finish—we have them all!

Write for our catalog and test sample of fastener needed.

And remember—if it is self-clinching it is PEM, the original self-clinching fastener design.

Circle 422 on Page 19





SELF-CLINCHING





SELF-CLINCHING



SELF-CLINCHING



SELF-CLINCHING



SELF-CLINCHING



SELF-CLINCHING

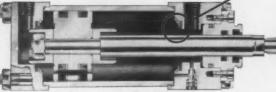
PENN ENGINEERING & MANUFACTURING CORP.

DOYLESTOWN . PENNSYLVANIA

NEW YORK (SELLE HARBOR, L.I.)—NEPTUNE 4-7103 CINCINNATI—GRANDVIEW 1-9011 CHICAGO (DOWNERS GROYE, ILL.)—WOODLAND 9-7770 MIAMI (SPYRAFLO, INC.)—NATIONAL 1-0566 INDIANAPOLIS—CLIFFORD 1-4020 DENVER—DUDLEY 8-4644 DETROIT—UNIVERSITY 3-5189 TOLEDO—GREENWOOD 4-9563 TORDONYO—PEL MONT 3-2161 MILWAUKEE—BLUEMOUND 8-5118 MINNEAPOLIS—GREENWOOD 4-6203
DALLAS—FLEETWOOD 7-5713 - LOS ANGELES—BRADSHAW 2-8097
SAN FRANCISCO (PALO ALTO)—DAVENPORT 1-243

WILBOW precision seals improve power cylinder action

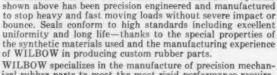




Check seal cushions by WILBOW provide effective cushioning of HANNA-POWR®*



SEND FOR COMPLETE WILBOW CATALOG



Each cushion valve in The Hanna POWRMATION®* Cylinder

ical rubber parts to meet the most rigid performance requirements. A full range of the newer synthetics, natural or silicone polymers plus the broadest production versatility . . . including molding, lathe cutting, extruding or punching . . . is at your service. Why not check your needs with WILBOW?

*HANNA-POWR and POWRMATION are registered trademarks of Hanna Engineering Works, Chicago, Ill.

The WILLIAMS-BOWMAN RUBBER CO.

1951 South 54th Avenue • Cicero 50, Illinois • (Chicago Suburb)

Mfrs. of molded, punched, extruded and cut rubber goods. Specialists in producing rubber covered rolls, silicone rubber parts and bonding rubber to metal

Please direct inquiries to advertiser, mentioning MACHINE DESIGN



PROFESSIONAL VIEWPOINTS

somebody spend a lot of time translating any dimension in the metric system, and vice versa. However, I call myself lucky that when Miss Universe reveals her top measurement as "95," I do not have to think any further but can appreciate that fact with a considerable amount of comparative feeling.

So far for the experienced folk. But what about our youngsters? They know what 50 ft of 8 mm film is, but they don't know what a meter is. They know that a soft drink bottle holds so many ounces, but they have no idea when they get oxygen administered by the litre. They know that I've got 7 x 50 binoculars, but they have no conception of what the 50 stands for.

All this is compensated for by a thorough education in social studies, competitive sports, and the definition: A kilowatt hour is a unit of current (in a text book used in seventh grade).

And so, I'm not worried at all. The experienced folk will keep using a marvelous system (unless they are in physics or chemistry, the poor misguided souls).

The youngsters are prepared thoroughly to keep the system going for years to come.

And if we ever get in a shooting war, what is the difference between getting killed by a 0.30 caliber rifle bullet or a 9 mm pistol shot? You either go 6 feet or 2 meter under. I hope by that time it'll be meters!

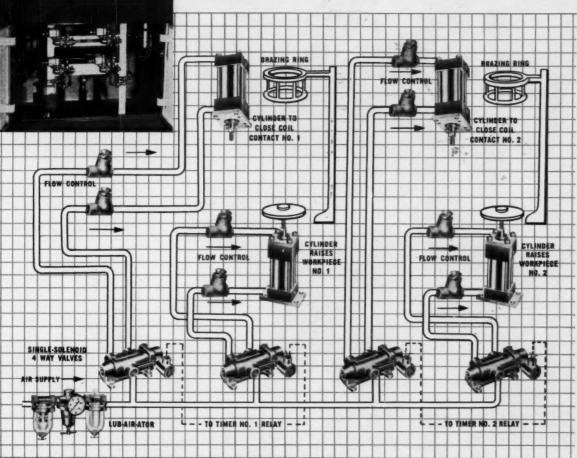
Hugo J. deBruin
Design Engineer
Ideal Industries Inc.
Sycamore, Ill.

To the Editor:

Every year the American engineer is asked by some oddballs to take his measurements in centimeters rather than in inches. The great Dr. E. Teller in an article entitled "We Are Losing by Inches . . ." went even so far to contribute the missile gap to the fact that the Russians used the more advanced centimeter system.

As I have pointed out repeatedly, the problem is not how to replace a system that divides the equator into 30,000 parts by another that divides

General Electric Company's Apparatus Service Shop in Detroit, Mich., uses Schrader air circuits to actuate and control this brazing machine. It enables one man to braze 120 planet carrier gear assemblies for automotive transmissions in one hour. Double-acting cylinders, actuated by solenoid valves, lift the assembly into position within the coil for brazing the shaft to the gear, and lower it for water quench. JIC cylinders control the induction heating coil contacts. According to Frank A. Ross, the designer, Schrader's Flow Control Valves close contacts so gently that they perform 750,000 cycles before needing replacement. In addition, air works successfully in a strong magnetic field, and the circuits can be simple.



TOUGH BRAZING JOB BECOMES A BREEZE... WITH SCHRADER AIR CIRCUITRY

PROBLEM: Strong magnetic field . . . complex movement of parts . . . speed requirements . . . precise actuation of coil contacts.

SOLUTION: Simple Schrader air control of mass production operations.

Schrader Air Products are designed to operate together in varied combinations to produce practically unlimited results. Their quality and versatility make them capable of simplifying production... while speeding it up... at unmatched low cost. Are you failing to ultilize fully the air you already have? Follow this Detroit plant's example. Examine your production facilities with air in mind. Make many operations simpler and more efficient by applying any or all of the complete line of Schrader Air Control Products.



This new Schrader catalog is available at your Schrader distributor, who is stocked with the complete range of sizes and types of Schrader air circuitry products. Consuit the Yellow Pages or write Schrader.

FULL LINES OF QUALITY AIR CIRCUIT COMPONENTS • OFF-THE-SHELF SERVICE AND INFORMATION FROM YOUR NEARBY DISTRIBUTOR • STAFFED WITH AIR CIRCUIT EXPERTS • CONSULT YELLOW PAGES OR WRITE FOR HIS ADDRESS



A. SCHRADER'S SON
Division of Scovill Manufacturing Co., Inc.
476 Vanderbilt Ave., Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS



Miniature Reed Relays

1, 2, 4 and 12-POLE ENCAPSULATED TYPES

12 poles in a sturdy unit only 2-1/8" long

(including leads) x 19/32" deep x 1-25/32" wide! . . .

1, 2 and 4-pole types similarly miniaturized . . .

designed for reliable light load switching . . .

In-line terminals for 0.1" grid center mounting . . .

Normal operate times less than 1 msec for 1-pole units . . .

2.5 msec for 12-pole . . .

Release less than 0.3 msec for all . . .

Write for Bulletin MRR-1 to:

Struthers-Dunn, Inc., Pitman, New Jersey

STRUTHERS-DUNN

World's Largest Assortment of Relay Types

Sales Emgineering effices in: Atlanta - Boston - Buffalo - Charlotte - Chicago - Cincinnati - Cleveland Dallas - Dayton - Denver - Detroit - High Point - Kanasa City - Los Angeles - Montreal - New York Orlando - Pittsburgh - St. Louis - San Carlos - Seattle - Toronto - Export. Langguth-Olson Co., New York it into 40,000 parts. It is rather how to express measurements in decimal units. This is widely done, wherever it is advantageous. All verniers on lathe and metalworking machines have the verniers in decimals. The ruler of every schoolboy is divided into inches and centimeters and lets him decide which is the best for his purpose.

DR. KARL M. WEIGERT
Assistant Professor
College of Engineering
and Agriculture
Pennsylvania State University
University Park, Pa.

... radar detector ...

To the Editor:

I was surprised to see your implied approval of lawbreaking by the "heavy-footed motorist" in noting the radar detector manufactured by Gepco Mfg. Co. [July 6 issue, Page 8].

As an electronics engineer and a microwave man, I know these gadgets can be built. As a driver of 24 years standing with no traffic violations it bothers me that such dangerous lawbreakers as chronic speeders should have available to them a device which will permit them to cheat more readily without detection. The sole "benefit" of such a device is to encourage lawbreaking and, to my way of thinking, falls into the category of a burglar's "jimmie" but is far more dangerous.

Such a device endangers me and my family on the highway and I am opposed to the sale, advertising, and reporting of this and similar devices.

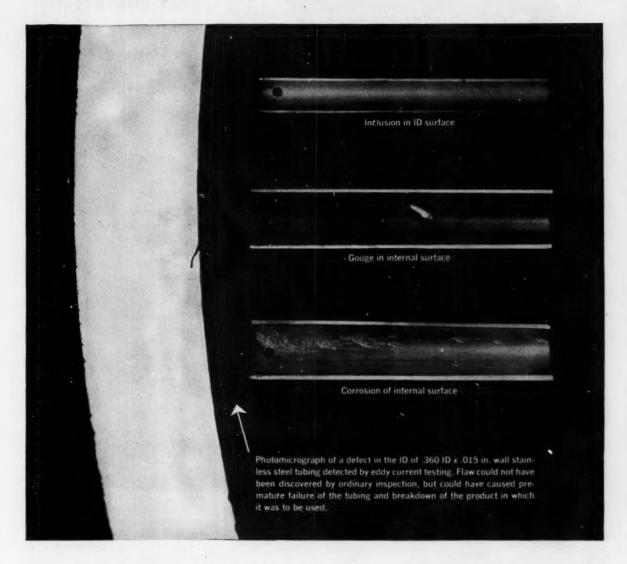
I am sure your publication would not print hints on "beating" safety interlocks and moving part guards on machines, and I feel that your interest in safety should extend beyond this small area.

JOE DIAZ
Johnson City, N. Y.

Our short paragraph concerning the radar detector was not meant to imply either approval or criticism—we merely reported the existence of a device which we thought would be of interest to our readers. Since Mr. Diaz has forced us to take a stand, however, we join him in condemnation of aids to lawbreakers.

-ED.

Tomorrow's tubing technology — today



Tubing Quality Verified by Nondestructive Tests

Superior tubing for critical applications must be consistently of highest quality and reliability. As a consequence, nondestructive testing is essential. Furthermore, several types of test should be performed, since no one test is versatile enough to supply all the required information.

Eddy current spots defects we don't want in Superior tubing, but it doesn't tell us everything about them. Neither does any one of the other seven nondestructive tests we use in checking the finished quality of our tubing.

Depending on how critical the end use of the tubing is and thus the amount of test information required, we can perform any of the following tests singly or in combination: eddy current, dye penetrant and fluorescent dye penetrant, ultrasonic, radiographic, hydrostatic, boroscopic and magnetic particle. Only in this way can we detect imperfections such as change

in analysis and dimension, pits, roughness, inclusions, weld defects, carburization, porosity, corrosion, laps, embedded particles, and surface oxides on OD and ID and in the wall of the tubing.

An article, "Nondestructive Testing of Small Tubing," details and compares the methods used. If you would like a copy, and technical data on the more than 120 analyses of small-diameter tubing produced in our mill, write us. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.



NORRISTOWN, PA.

West Coast: Pacific Tube Company, Los Angeles, California



PERFECTION Worm Gear SPEED REDUCERS



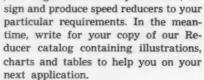
One of our major capabilities is to design, develop and produce speed reducers that will insure maximum performance and economy in your operation. Our experience in the special problems and objectives of power transmission is broad and deep. The men at American Stock Gear having this important capability, use the most advanced analytical engineering facilities to design speed reducers to meet tomorrows needs.



Whatever size or style reducer you need, you'll find the right combination in the complete Perfection line — a line that is precision engineered and performance tested in thousands of different applications.



If you have a reducer problem that you feel is "different", our engineers are ready to advise, de-



We make a complete line of stock gears. Send for Gear catalog No. 360.











AMERICAN STOCK GEAR DIVISION

THE ENGINEER'S

Library

Recent Books

Temperature Measurement in Engineering, Vol. II. By H. Dean Baker, E. A. Ryder, and N. H. Baker; 510 pages, 6 by 9 in., clothbound; published by John Wiley & Sons Inc., 440 Park Ave. South, New York 16. N. Y.

This volume is divided into two parts, techniques and applications. In part 1, two chapters each are devoted to resistance thermometry and to radiation pyrometry: one a descriptive chapter and the other an analytical chapter. In the analytical chapter, a systematized design procedure is developed. Part 2, the larger part of the volume, is devoted to a selected assortment of actual problems including surface temperatures, moving bodies, transparent bodies, high temperature gases, flame temperature, and nuclear reactor temperatures.

Developing Competent Subordinates. By James Menzies Black; 128 pages, 5½ by 8½ in., clothbound; published by American Management Association, Press Relations Dept., 1515 Broadway, New York 36, N. Y.; \$4.50 per copy.

This book suggests ways for the responsible supervisor to develop the individual workers who report to him. It shows how he can give more time and thought to the basics of worker education, improve his own skills in communication, organize his department to realize the technical and managerial potential of his personnel, and at the same time improve his own performance and skills. Committees, conferences, job rotation, and other management development tools are discussed, and practical suggestions are given for dealing with problem employees.

Tool Steel Simplified. By Frank R. Palmer and George V. Tuerssen; 595 pages, 6 by 9 in., clothbound; published by The Carpenter Steel Co., Reading, Pa.; \$2.50 per copy.

This book offers a comprehensive source of information on tool-steel selection and application, based on

What's News in Rubber...



ENJAY BUTYL BEATS HEAT-WEATHER-WEAR

Continuous contact with materials as hot as 350°F (as in this conveyor belt) presents no problem to Enjay Butyl HT10-66 when properly compounded for heat resistance. Actual service shows that other grades of Enjay Butyl also have exceptional resistance to high-temperature aging in ordinary atmospheres, oxygen or super-heated steam.

For application data, or for technical assistance in applying Butyl, write to Enjay, 15 West 51st Street, New York 19, New York.



Lightweight, durable, permanently flexible and applied cold, this colorful new roofing system at Longway Planetarium in Flint, Mich., takes full advantage of the unusual flexibility and non-hardening properties of Enjay Butyl.



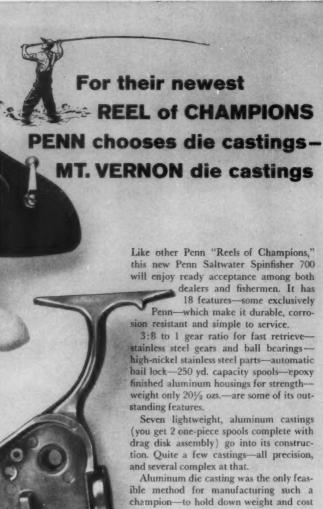
New Enjay Butyl HT 10-66 adds toughness to air-holding innerliners which help assure correct inflation pressure on tubeless tires; gives greater blowout protection and improved tire-tread wear. Also used for sidewalls and chafer strips.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY





and yet satisfy Penn's traditionally high standards of craftsmanship.

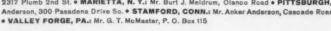
To Mt. Vernon went the honor of making the castings, because Mt. Vernon-like Penn-also enjoys a reputation for high standards of workmanship. At Mt. Vernon you gain through a fourfold service embracing: Designing · Die Making · Casting · Machining-all under one roof in 200,-000 sq. ft. of space.

You, too, can set your standards as high as you wish-then confidently give your specifications to Mt. Vernon and relax. You'll get champion castings. A call to your nearest Mt. Vernon field salesman or our home office will get you prompt action.

MT. VERNON DIE CASTING CORPORATION

Stamford, Connecticut

FIELD SALESMEN-BALTIMORE, MD.: Mr. C. M. Gordan, 919 St. Paul St. . BROOKLYN, N. Y.: Mr. Robert V. Moore, 2317 Plumb 2nd St. • MARIETTA, N. Y.: Mr. Burt J. Meldrum, Olanco Road • PITTSBURGH, PA.: Mr. Andrew W. Anderson, 300 Pasadena Drive So. • STAMFORD, CONN.: Mr. Anker Anderson, Cascade Road





the experience and knowledge of tool steel experts. Sample chapter titles include: Analysis of tool steel, heat treating methods and equipment, mechanical testing of tool steels, air-hardening steels, timber and hardenability tests, spark testing, and quenching and tempering.

British and Foreign Specifications for Steel Castings, Part 2. 29 pages, 8 by 10½ in., paperbound; published by The British Steel Castings Research Association, East Bank Road, Sheffield, England; \$7.50 per copy.

This book provides a guide to the identification of overseas standard specifications for steel castings and their equivalents in British Standards. It analyzes the specifications of Australia, Canada, Denmark, India, Japan, New Zealand, South Africa, and the U.S.S.R. An appendix gives a summary of test piece dimensions.

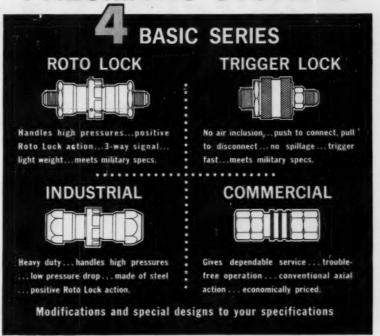
The Employment Interview. By Milton M. Mandell; 110 pages, 8½ by 11 in., paperbound; published by American Management Association, Press Relations Dept., 1515 Broadway, New York 36, N. Y.

Reports on two AMA surveys of current interviewing practices in 273 companies and 140 college placement offices are presented. Every aspect of the employment interview is discussed: How much time to spend, use of the preliminary interview, when and how to use multiple or consecutive interviews, the depth interview, and group discussion. Statistical data and 28 pages of reproductions of actual personnel forms used by leading companies are included.

Nondestructive Testing. By Warren J. McGonnagle; 455 pages, 6 by 9 in., cloth-bound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from Machine Design, \$15.00 postpaid.

This comprehensive reference book provides detailed coverage of various methods and techniques of nondestructive testing. In treating the field as a technology based on applied physics, special attention is placed on work in the area of atomic energy. Among the topics discussed are visual testing, pressure and leak testing, liquid penetrant inspection, thermal methods, x-ray

FOR ALL HYDRAULIC AND PNEUMATIC SYSTEMS



... specify J&H COUPLINGS

Whether you have a project for aero-space or for general industry, you should investigate the many advantages of Jack & Heintz quick-connect fluid couplings.

The Roto Lock and Trigger Lock Couplings are unexcelled for quick-connect applications over a wide range of high-integrity functions, from air to exotic fluids. In addition there is a series of new GSE Couplings for advanced pneumatic systems.

In more conventional systems, the Industrial and Commercial Couplings are recommended. They assure dependable performance. Easy to operate. Positive action. Available from stock.

In most cases you will find that one of the four basic J&H Couplings will do the job. If not, we will modify it for you, or develop completely new designs.

Get all the facts about the full line of J&H Couplings! Fill in and mail the coupon below.

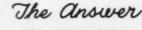


JACK & HEINTZ
A DIVISION OF THE SIEGLER CORPORATION



JACK & HEINTZ 17607 Broadway, Cle	eveland 1, Ohio
Please send catalog on □ INDUSTRIAL and COM	ROTO LOCK TRIGGER LOCK
Name	
Company	LEASE PRINT)
Company	
Address	

Featherweight BEARINGS ... by MESSINGER



to High Load-Carrying Capacity With Substantial Reduction in Over-all Weight of Product.

Two Hundred Forty Standard Signs...
Offering Widest Latitude in Design
Applications...

~ [I.D.	O.D.	WIDTH
'drom	2.00"	2.50"	.250"

a	I.D.	O.D.	WIDTH
Jo	60.00"	62.00"	1.00"

Minimum and maximum cross-sections for range of standard sizes are shown in actual size, at left.

In contrast with their extremely light weight and slender section, these "FEATHERWEIGHTS", like all other Messinger Bearings, are made to give years of precision performance under surprisingly heavy loads. They lend themselves to an exceptionally broad range of applications in the design of appliances, instruments, machinery and equipment of many types. Write for Catalog No. 59.



You can "work wonders" with product design when you consider "Featherweight" Bearings by Messinger. Consultation invited, without obligation

MESSINGER



BEARINGS, Inc.

FEATHERWEIGHT TO HEAVYWEIGHT

D STREET ABOVE ERIE AVE. . PHILADELPHIA 24, PA.

"Smoothing Industry's Pathway for Nearly Half a Century"

radiography, Gamma radiography, ultrasonics, magnetic methods and eddy current methods.

New Codes

Supplements on Instruments and Apparatus to the Power Test Code, Parts 3, 7, and 13; 118, 29 and 17 pages, respectively, 8½ by 11 in., paperbound; published by The American Society of Mechanical Engineers, 345 East 47th St., New York 17, N. Y.; \$5.50, \$2.50 and \$2.00 respectively.

Part 3, Temperature Measurement, replaces a segment of the test codes originally published in eight chapters. The volume includes nine chapters on such topics as calibration of instruments, various kinds of thermometers, and optical pyrometers. The first chapter also includes a summary discussion of temperature measurement as related to power-test code work with particular emphasis on basic sources of error and means of coping with them.

Part 7, Measurement of Shaft Horsepower, is a new addition to the series. It reflects a need for a description of various types of instruments and methods of measurement likely to be prescribed in any of the ASME Power Test Codes. It includes such details as the limits and sources of error, method of calibration, and precautions.

Part 13, Measurement of Rotary Speed, is a revision of an earlier edition last revised in 1939. As a result of a program of co-operation between the committee developing the supplement and a committee of the American Institute of Electrical Engineers, much of the supplement is identical with the current AIEE Guide on Rotary Speed Measurements. The new edition reflects the ever increasing speeds of machines and power units as well as development of new apparatus for detecting and indicating these high speeds.

1960 Supplement to the Book of ASTM Standards, Parts 1, 2, 3, and 9; 444, 348, 180, and 494 pages respectively, 6 by 9 in., paperbound; published by The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; \$4.00 per part.

Part 1, Ferrous Metals Specifica-



Here's a PERFECT PAIR of miniature, hermetically sealed motor driven timers for both airborne and ground support applications. Operative in 12 G acceleration, these versatile units perform reliably in extremes of vibration and temperature.

SPECIFICATIONS

• COMPACT — 21/4 x 41/2" outside cylinder dimensions • LIGHT WEIGHT — 30 oz. or less • UP TO 7 independent load circuits • TIME CYCLES — I second to several hours • POWER INPUT — Choice of 115 V., 60 cycle; 115 V., 400 cycle; 28 V.D.C. • FLEXIBLE — Can be equipped with plug-in header for quick change of time cycles

Write for Bulletins 825 and 830 or call your local Eagle Representative. He's listed in Sweet's Product Design File, Section 7d, or in Thomas Register.

TIMERS ALSO CUSTOM-BUILT TO MIL-SPECS. COMPLETE FACILITIES FOR QUALIFICATION TESTING.













Plug-in Reset Precision Interval

Multiple Circuit

Pneumatic Timers

rtic Heavy Duty Heavy-Duty
rs Repeat Cycle Timers Step Switch



EAGLE SIGNAL COMPANY • Moline, Illinois INDUSTRIAL DIVISION

DIVISION OF THE GAMEWELL COMPANY, AN E. W. BLISS COMPANY SUBSIDIARY

MANUFACTURERS OF THE MOST COMPLETE LINE OF GROUND SUPPORT TIME CONTROLS.



Replace costly machined or molded parts with formed RULON® Tape.

Leading manufacturers across the country are cutting design costs by stamping or post-forming parts from RULON (filled TFE) tape. With Dixon's RULON Tape in thicknesses

RULON and

TEFLON In

• reds

· tubing . sleeving - sheet

. tape

. bearings

. bushings

· washers

from .004" to .125" you pay only for what you use. You use a minimum of material . . . and reduce costs up to 10 to 1. You take advantage of RU-LON'S plastic memory, too, for tighter fits and better seals. · extruded shapes **RULON Tape gives** your product these performance-improving qualities: (1) low friction, (2) high gaskets and packings wear resistance, (3) · bearing retainers low deformation under load, (4) wide

temp. tolerance (-400°F to +500°F), (5) chemical inertness, (6) lube-free operation, and (7) zero water absorption.

Whether you need stamped or postformed parts for pumps, valves, compressors, bearings, meters, or what have you, it pays to rely on (1) Dixon's wide selection of basic shapes (in both RULON and Teflon), (2) Dixon's knowledge of fluorocarbon reinforcing agents, and (3) Dixon's facilities for fabricating parts to print.

See RULON designers guide book — Bulletin #9572 in Sweet's Product Design File, or send details for recommendations. DIXON CORPO-RATION 100 BURN-SIDE ST., BRISTOL. BRISTOL, RHODE ISLAND. # DuPont T.M.



Circle 433 on Page 19

ENGINEER'S LIBRARY

tions, includes 63 standards on steel pipe, tubes, castings, bolting materials, boiler plates and rivets, bars, forgings, chain, corrosion and heat-resistant steels, and others.

Part 2. Non-Ferrous Metals Specifications and Electronics Materials, includes 57 standards for copper and copper-base alloys, ingot, plate, sheet, strip, rolled bar, shapes, wire, die forgings and pipe and tubes. In addition, there are standards for die-cast metals, aluminum and aluminum alloys, magnesium and magnesium alloys, and metallic electrical conductors.

Part 3, Methods of Testing Metals (Except Chemical Analysis), includes 19 standards for tests of mechanical properties, effect of temperature, dosimetry, and electrical and magnetic properties. Also included are nondestructive metallographic tests, and tests for metal powders.

Part 9, Plastics, Electrical Insulation, Rubber, and Carbon Black, includes 68 standards for rubber elastomers, latex, carbon black, sponge, hard rubber, coated fabrics, belting, hose, gaskets, and automotive and aeronautical products.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TR 60-56. A compendium of the Properties of Materials at Low Temperature, Phase I. Edited by Victor J. Johnson. National Bureau of Standards; 161 pages, 3% by 10% in, paperbound; \$3.00 per copy.
This first phase of the compendium covers ten properties of ten fluids (Part I), three properties of solids (Part II), and an extensive bibliography of references (Part III). Data sheets, primarily in graphic form, are presented from "best values" of data collected. References and tables of selected values with appropriate comments are furnished with each data sheet to document the data presented. Conversion tables and other helpful information are included.

TN D-1070. Skin Stresses in an Inflated Sphere During Impact. By E. Dale Martin, Ames Research Center; 34 pages, 7% by 10% in, paperbound, stupled; \$1.00 per copy. An analysis is made of the stresses in the skin of an inflated nonstretchable sphere during normal nonrotating impact with a hard of the surface. The analysis is further analysis.

flat surface. The analysis is further applied to the study of the inflated sphere landing whicle containing a payload suspended at the center. Curves are presented showing the stress distributions during impact for cases corresponding to those calculated in previous

reports.

ARO Report No. 2. Second Status Report on Fuel Cells. By B. R. Stein and E. M. Cohn; 76 pages, 8 by 10½ in., paperbound, stapled. This report covers recent literature and government and private programs on fuel-cell research and development. Government inhouse and contract work ranges from research to systems development, including power for portable packs, ship propulsion, and regenerative systems for space satellites. Industrial work also includes this range but concerns mostly organic fuels and oxygen or air as oxidant.



Don't blindfold him!

THE MAN in this picture is a cancer research scientist. The device he is using looks like something out of science-fiction-but actually, it's an electron microscope. It shows him the sub-microscopic detail of a cancer cell -magnified 100,000 times. The cost of one electron microscope is \$35,000.

Some of the equipment needed for cancer research, and purchased with American Cancer Society funds, is even more expensive.

The American Cancer Society grants millions of dollars for research to some 1300 scientists who are at this moment working to find the cause of cancer-and ultimately,

ways to prevent cancer. Your help is needed to enable the American Cancer Society to continue this support.

Don't blindfold cancer research. Give to it. Send your contribution now to CANCER, c/o your local post office.

> **AMERICAN** CANCER SOCIETY









Memo to the engineer who hasn't used microfilm cards as yet!

No doubt you've read about Recordak precision microfilm images mounted in aperture cards, and how they are speeding routines in drafting rooms large and small.

But you may have some questions . . . are perhaps wondering just how they can help on your job.

For a start, consider a few of the advantages: you'll be able to keep all of your drawings—thousands of them—in a small card file at your finger tips. You'll be able to refer to any one of them in seconds in a Recordak Film Reader... no more "waiting" for costly prints every time you want to check a drawing. Whenever needed, low-cost, paper facsimiles—or duplicate film cards—can be made in seconds directly from the master card.

TRECORDAK®

(Subsidiary of Eastman Kodak Company)
originator of modern microfilming
—now in its 34th year

IN CANADA contact Recordak of Canada Ltd., Toronto

There's much more to the story. You must see for yourself how Recordak precision microfilming reproduces drawings of all types and ages with remarkable uniformity; how it gives you "drawings in miniature" that more than meet DOD requirements. Then you'll have a better idea why so many leading companies use Recordak microfilm-in-cards.

Free booklet goes into more details on precision microfilming available through Recordak or a microfilming dealer of Recordak.

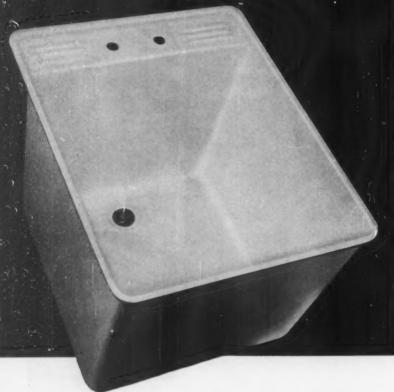
AS ALL	COUPON	TODAY
MAIL	COUPOR	IODAI

RECORDAK CORPORATION
415 Madison Ave., New York 17, N. Y.
Send booklet describing Recordak Engineering Drawing System and name of nearest microfilming dealer of Recordak.

Name______Company_______

Address______Zone___State____

What's so unusual about a laundry tub?



This particular tub was molded of Fiberglas reinforced plastics using the new premix process pioneered by AICO. It has an unusually smooth finish, is exceptionally strong and is unusually low in costs. The new premix process opens up many new opportunities to use reinforced plastics. Why not see if you can't capitalize on it, too.

AMERICAN INSULATOR

New Freedom, Pa.

Where tomorrow's plastics are now being molded

Circle 436 on Page 19

Complete reprints of major article series and collections of articles, and extra copies of Machine Design Books, are available from: Reader Service, Machine Design, Penton Bldg., Cleveland 13, Ohio. Remittance or company purchase order must be enclosed with your order. Add 3 per cent to orders in Ohio to cover State Sales Tax.

The Ferrous Metals Book, 1961 Edition (196 pp.) \$2 The Bearings Book, 1961 Edition (256

pp.) \$2 The Seals Book, 1961 Edition (240 pp.)

The Fasteners Book, 1960 Edition (236

pp.) \$2 AC Motor Control, by J. Ronald Wickey and Arthur S. Newman, Jr., 1960-1961

AC Motor Control, by J. Ronald Wickey and Arthur S. Newman, Jr., 1960-1961 (40 pp.) \$1

Preventing Fatigue Failures, by F. B. Stulen, H. H. Cummings, W. C. Schulte, 1961 (32 pp.) \$1

Simplified Vibration Analysis by Mobility and Impedance Methods, by R. P. Thorn & A. H. Church, 1959-1960 (80 pp.) \$2

Inside the Engineer, by Eugene Raudsepp, 1958-1960 (52 pp.) \$1

Mobility of Cross-Country Vehicles, by M. G. Bekker, 1959-1960 (32 pp.) \$1

Engineering Approach to Hydraulic Lines, by Jaroslav J. Taborek, 1959 (36 pp.) \$1

Planning New Products, by Phillip Marvin, 1953-1958 (102 pp.) \$3

Friction-Clutch Transmissions, by Z. J. Zania, 1958 (30 pp.) \$1

Design Guide—Flexible Couplings, by Leo F. Spector, 1958 (28 pp.) \$1

Special Report on Electric Motors, Staff Report, 1958 (42 pp.) \$1

Electronic and Electric Power Supplies (Symposium), 1958 (40 pp.) \$1

Human-Factors Engineering, by J. D. Vandenburg and C. T. Goldsmith, 1958 (32 pp.) \$1

Mechanics of Vehicles, by Jaroslav J. Taborek, 1957 (94 pp.) \$2

Design for Fatigue Loading, by Joseph Marin, 1957 (34 pp.) \$1

Hydraulic Servo Fundamentals, by J. M. Nightingale.
Volume 1: May-Nov., 1956 (32 pp.) \$1

Volume 1: May-Nov., 1956 (32 pp.) \$1 Volume 2: Nov., 1956—Mar., 1957 (30 pp.) \$1 Volume 3: May, 1957—Feb., 1958 (44

pp.) \$1 Adjustable-Speed Drives (Electrical-Me-chanical-Hydraulic), Staff Report, 1954-

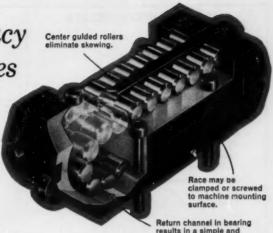
Chancal-riydraulicy, Staff Report, 1954-1955 (146 pp.) \$2 MACHINE DESIGN Data Sheets 1960 (130 pp.) \$2 1957 (102 pp.) \$2 1958 (132 pp.) \$2 Transactions of the Mechanisms Confer-

eness
Sixth Conference, 1960 (152 pp.) \$2
Fifth Conference, 1958 (240 pp.) \$3
Fourth Conference, 1957 (104 pp.) \$2
Third Conference, 1956 (40 pp.) \$1
Second Conference, 1954 (50 pp.) \$1
First Conference, 1953 (48 pp.) \$1
Tips and Techniques
Vol. 1—Drafting Aids, 1956-1957 (32
pp.) \$1
Vol. 2—Engineering Aids, 1956-1958 (30
pp.) \$1

Machine speed and accuracy increased with Scully-Jones

TYCHOWAY BEARINGS

Tychoway recirculating roller bearings equalize starting and moving friction ... permit fast, accurate positioning of heavy workpieces on this Burgmaster tape-



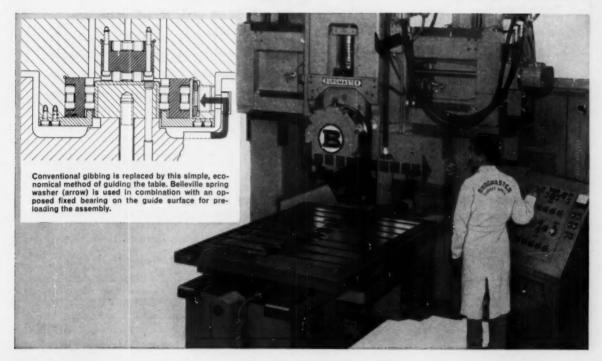
results in a simple and compact assembly.

controlled turret drill. So accurate and easy to preload, bearings are used for guiding as well as for supporting the table. With low coefficient of friction (less than .005), X-Y axis positioning of table and turret carriage (also antifriction equipped) is accurate and repeatable. Accuracy lasts longer, too —wear on critical assemblies is virtually eliminated. How many ways can you improve your product and add to its salability by eliminating friction in heavy, sliding assemblies? Write for Bulletin 22-50.

Special Products Division



cully-Jones and Company 1905 South Rockwell Street, Chicago 8, Illinois



Planetary Gear Trains By William H. Wilkinson

Geneva Mechanisms By Marshall C. Smith **Cooling By Evaporation** By Robert M. Sando **Galvanic Corrosion** By Eugene D. Veilleux

Plastics For Extrusions By Robert Marx

By F. Caplan

Low Temperature Properties By Randall F. Barron Thermal Stresses

Control-Movement Direction By Joseph L. Seminara **Planetary Gear Ratios** By Reed H. Langdon **Polyhedrons**

Calculating Weight and Volume

Acceleration Velocity Distance Time

Pulley Diameter vs Wire Size

By C. M. Daniels and R. E. Fenton **Designing Cams For Analog Computers**

Beams With Partial Uniform Loading

By Alexander Blake and George Kurasz

Compressibility of Fluids By Robert M. Sando Flexible Metal Hose

By Charles Eumurian

Moment of Inertia Charts

Reader Service Department

Beam Vibrations By Gerard T. Klees

By Robert A. Johns Plate Vibrations By Gerard T. Klees

Penton Building

By Joseph J. Fousek **Four-Gear Combinations**

By Robert G. Gerber

By M. E. Arthur Brakes

By H. A. Borchardt **Planetary Drives**

By Jacob Shuster **Fastener Vibration**

By Gerard T. Klees

By V. F. DeVost

Cold Heading By E. F. Tauscher

Curved Beams

By Chen Ya Liu

By J. Paull

DESIGN

NOW READY 1960 Data Sheets

PLUS-a cumulative index of all 1956-1960 Data Sheets

Twenty-six reference articles of valuable design techniques published in the 1960 issues of MACHINE DESIGN are included in a new 127-page reprint now available. Each data sheet begins on a right-hand page for clipping ease without destroying other pages. Prepared with your personal file of engineering information in mind, each volume contains a five-year index of published data sheets available.

Price is \$2.00 each, including postage

These worthwhile data sheets offer a unique collection of basic design assistance. Order your personal or departmental copy today. Use the convenient form below for prompt processing.

> (Remittance or Company Purchase Order must be enclosed with order)

Cleveland 13, Ohio

Please	send	me	_copies	of	the	1960	Data	Sheets	@	\$2.00	each	

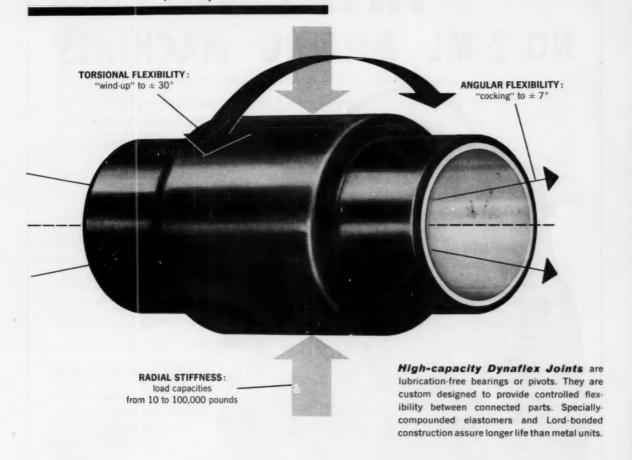
Company .

State Zone City ___

(Add 3% to orders in Ohio to cover State Sales Tax)

DESIGN FOR SUPERIOR PERFORMANCE

with Lord vibration/shock/noise control



reduce installed cost, eliminate lube points with Lord Dynaflex Joints

Pivot points utilizing Dynaflex Joints offer real improvements in economy and performance.

These elastomeric pivots simplify assembly. Pressed directly into the as-cast recess or rough-machined socket, they insure positive radial positioning of parts. Exacting tolerances are not required; costly machining is eliminated. Grease fittings and periodic lubrication are outmoded; overall maintenance is greatly reduced.

Dynaflex Joints—used in torque and radius rod ends, load equalizer beams, spring eyes, machinery linkages, boom pivots—cushion shock, attenuate noise, reduce dynamic loading stress, assure accurate alignment.

Dynaflex Joints, with lower installed cost and longer service life than metal bushings, can be specially engineered for your application. Contact your nearest Lord Field Engineering Office listed here or the Home Office, Erie, Pa.

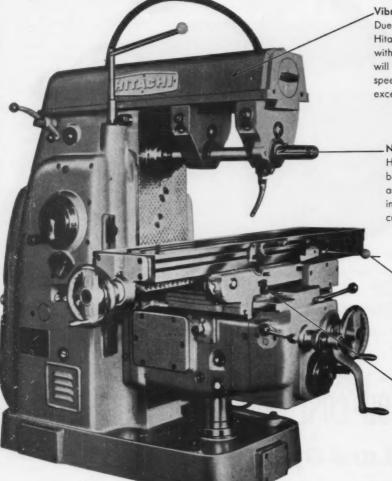


FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA · CEder 7 · 9247 BOSTON, MASS. · HAncock 6 · 9135 CHICAGO, ILL. · MIchigan 2 · 6010 DALLAS, TEXAS · Riverside 1 · 3392 DAYTON, OHIO · Baldwin 4 · 0351 DETROIT, MICH. · Etgin 7 · 2150 KANSAS CITY, MO. · WEstport 1 · 0138 LOS ANGELES, CAL. HOlfywood 4-7593 NEW YORK, N. Y. (Paramus, N. J.) New York City. BRyani 9-8042 Paramus, N. J. Diamond 3-3-333 PHILADELPHIA, PA. PEnnyacker 5-3559 SAN FRANCISCO, CAL. - EXbrook 7-6280 WINTER PARR, FLA. - Midway 7-5501

LORD MANUFACTURING COMPANY . ERIE, PA.

HITACHI NO. 2 ML MILLING MACHINES



Vibration Damping Device

Due to a vibration damping device of Hitachi's exclusive design contained within the over-arm, minimum vibration will be set up even during higher speeds and feeds operation, so that an excellent finished surface is obtained.

New-Type Arbor Support Bearing Hitachi's unique super precision-type bearing, a combination of plain metal and needle bearing, is incorporated into the machine to enable high speed cutting with high precision results.

Mono-Lever Control System

Hitachi's unique Mono-lever Control System makes the operation simple and easy. Table-feeding too can be performed with ease.

Backlash Eliminator of Lead Screw

As the use of two independent nuts eliminates backlash on the table feed screw, smooth down-cutting can be effected.

No. 2 ML Plain Milling Machine

SPECIFICATIONS :

- 53 1/8"×10 1/16" Table
- 28" Longitudinal Traverse
- 16 Table Feeds 1/16" 78 3/4"/min.
 - 16 Spindle Speeds 25 1,500 r.p.m.
 - 7.5 h.p. Main Motor



Tohyo Japan

Cable Address: "HITACHY" TOKYO

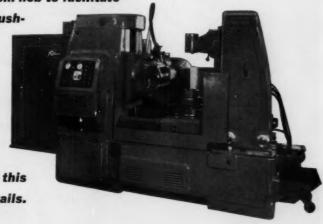
NOW...A Larger Capacity FELLOWS-PFAUTER High-Speed Hobbing Machine...The P 630

You get all the advanced-design features of the production-proved P 400 Fellows-Pfauter hobbing machine — plus extra work capacity — with this new Model P 630. Takes work up to 25" diameter. Maximum face width at 25" diameter is $16\frac{1}{4}$ ". Maximum diametral pitch in steel is 3.

Work area is readily accessible for setup and loading, and table retracts automatically from hob to facilitate work changes. Hob shifting is by push-

button. It's solid too, with rugged hob head and double wall construction column and bed, and heavy V-ways. Table is as large as maximum workpiece diameter — work column of massive design.

Reduce your production costs with this new Fellows-Pfauter. Write for details.



NEW... Dictionary of Change-Gear Combinations

"Fellows-Pfauter Change Gear Tables" by F. Becher and A. Koerner eliminates tedious calculations and trial-and-error methods. Gives combinations for more than 26,000 ratios carried to six decimal places

from .100,000 to 1.000,000, with greatest step approximately .00005. Gears in range of 18 to 80 teeth mainly used. Examples are given. Only \$8.00. Order from THE FELLOWS GEAR SHAPER COMPANY, 78 River St., Springfield, Vermont, U.S.A.

THE FELLOWS GEAR SHAPER COMPANY 78 River Street, Springfield, Vermont, U.S.A.

Branch Offices:

ices: 1048 North Woodward Ave., Royal Oak, Mich. 150 West Pleasant Ave., Maywood, N. J. 5835 West North Avenue, Chicago 39 6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE

Fellows

Gear Production Equipment



9 billion dollars to build a better one.

We're living in a needing, buying, growing America—a time for new and improved products and services—the creation of new jobs. More than ever, a businessman with an idea, with the urge for something better will move ahead with our expanding economy.

But after the idea, what follows can be a costly period of research and development. Not necessarily—if you use the immense 9-billion-dollar fund of research and patent information that's available at your U.S. Department of Commerce. Think of the saving—in time and money.

For example: there are reports on extensive research by your Government in new products and processes. A trans-

lation of data on inventions and discoveries abroad — information on over 3 million patents — a fortune in patents owned by your Government. All this is yours — for your use and your benefit.

Take advantage of the many ways in which your business can grow. In developing new products and services. In the lucrative foreign markets. In new U.S. markets. In attracting new industry to your local community. Just phone or write the U.S. Department of Commerce Office of Field Services in your city, or Washington 25, D.C. Your U.S. Department of Commerce is always ready to help you grow with America!

NOW'S THE TIME TO GET GROWING IN A GROWING AMERICA!

This Sandusky Centrifugal Casting—one of four produced for Westinghouse Atomic Equipment Department—meets radiographic, intergranular corrosion, and all other rigorous chemical and physical tests.



ENTRIFUGAL CASTING ... makes 4 giant stator shells

Specified by Westinghouse for 4 canned motor pumps soon to be integral parts of reactor system in Yankee Atomic Electric Plant in Rowe, Massachusetts

One king-size 17-ton Sandusky casting supplied the main motor bodies (stator shells) for the four pumps being built by Westinghouse, each to handle 23,600 g.p.m. of pressurized water through the reactor core.

The 25-foot-long Sandusky casting was centrifugally spun of a modified CF-8 (Type 304 L) stainless steel, then machined by Sandusky to a 3" wall thickness, 31½" on the O.D. This huge casting was

hydrostatically tested to 3800 psi before being sectioned into four 68" lengths.

These stator shells represent another new and exacting application for Sandusky Centrifugal Castings—which may offer a practical and economical answer to your cylindrical requirements also. They are available in diameters from 7" to 54"—in lengths up to 33 feet—in heat- and corrosion-resistant stainless, carbon and lowalloy steels and a wide range of copper-base and nickel-base alloys.

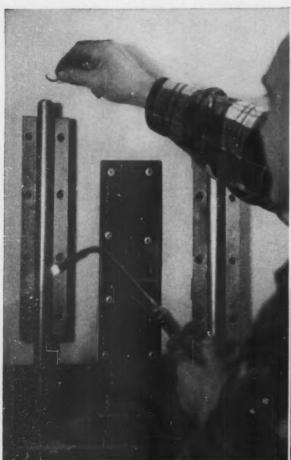
Let us show you how Sandusky Centrifugal Castings can help solve your cylindrical problems. Write to us at Sandusky, Ohio.

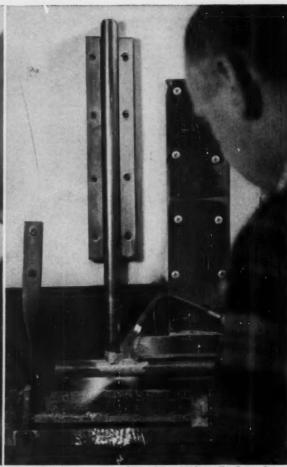
SANDUSKY O CENTRI

CENTRIFUGAL CASTINGS

FOUNDRY & MACHINE CO.

SANDUSKY. OHIO Stainless, Carbon, Low-Alloy Steels - Full Range Copper-Base, Nickel-Base Alloys





Joining tubular members is easy for Howe Folding Furniture, Inc., of South Norwalk, Conn. Joints are fluxed with Handy Flux, a half-circle preform of EASY-FLO brazing alloy is dropped down the tube and a torch is applied. Result: A smooth, strong joint quickly and economically made.

How Handy & Harman Brazing Alloys

GIVE FOLDING FURNITURE 100% JOINT RELIABILITY

The experience of Howe Folding Furniture, Inc., with silver brazing merits close attention if your operations involve metal-to-metal joining of any kind. Howe manufactures folding metal tables and seats for commercial, industrial and institutional use. You can imagine the hard usage the furniture has to take—yet survive indefinitely.

Some years ago, it was Howe's practice to purchase prefabricated steel tubular assemblies in which the joints were brass brazed on the outside surface. To improve their product, Howe thoroughly tested all joining methods, and decided to go over to silver brazing in their own plant, using Handy & Harman EASY-FLO Alloys 45 and 35. Look at the results:

Complete Joint Reliability: Since adopting silver brazing, Howe has completely eliminated the problem of broken joints.

Economy: Silver brazing costs Howe less than other methods, requires less heating time, simpler equipment, much less cleaning and grinding of joints.

Appearance: Silver brazing provides a smoother, more attractive joint, that can be plated directly.

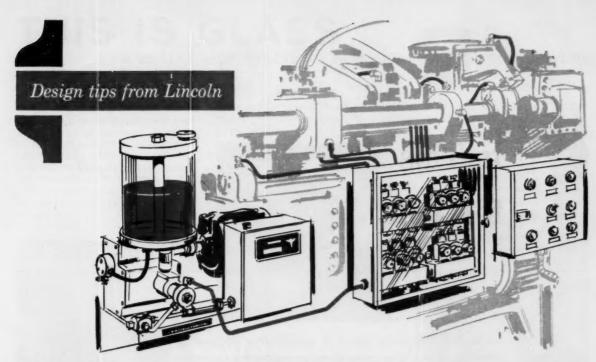
Is it any wonder Howe says: "We'd stay with silver brazing even if it cost more." There are few fields of industrial activity where the strength, high production rates and economy afforded by the Handy & Harman family of silver brazing alloys cannot improve the look of the balance sheet. Interested in complete details? Just write for a copy of our Bulletin 20—it's packed with engineering and application data.



Howe cafeteria table-bench is converted to an auditorium bench with backrest in a single motion. Silver brazed joints easily absorb strains.



850 Third Avenue, New York 22, N.Y. PLaza 2-3400



Provide automatic lubrication system with compact, reliable Electro-Luber°

Lincoln's Electro-Luber answers your need for a compact, reliable lubricant pump that's easy to design into machines of all types.

The high-pressure Electro-Luber feeds injectors that meter the exact amount of lubricant you specify directly to the individual bearings. Look how much flexibility you have with this system: 1) injector output is adjustable and you have a wide choice of capacities; 2) pump cycling frequency is adjustable; 3) you can tie Electro-Luber and machine controls together so lubrication is automatically scheduled with machine operation; 4) the Electro-Luber also has manual control for cycling prior to machine operation if desired.

Here's a tip to consider: Mount the injectors in a

panel near your other controls and signals for easy visual inspection of every injector-to-bearing line.

An Electro-Luber system enhances the sales appeal of your machines, protects your customers by taking the human element out of machine lubrication, insures maximum service life for critical parts, saves maintenance costs, gives smoother operation and eliminates down-time for manual lubrication.

Note to Manufacturers: Lincoln will help you determine the best automatic lubrication system for your machinery. Contact the Original Equipment Sales Division.

Mail This Coupon Today!

Electro-Luber	Power Rec	quirements		Lubricant
Model No.	Motor	Timer	Lubricant	Pumping Pressure
1848	3 PHASE 220-440 V/AC	115 V/AC 60 Cycle	Oil	1000 PSIG
1849	3 PHASE 220-440 V/AC	115 V/AC 60 Cycle	Oil or Grease	2900 PSIG
700226	3 PHASE 220-440 V/AC	115 V/AC 60 Cycle	Oil or Grease	2500 PSIG

4010 Goodfellow Blvd., St. Louis 20, Mo.	
systems.	talog 82 on Lincoln centralized lubricating
[] H	testing and to redules on administration to most
machines.	tative call to advise on adaptation to my
	Title
machines.	
machines.	



LINCOLN ENGINEERING COMPANY

ST. LOUIS 20, MO.

DIVISION OF THE MCNEIL MACHINE & ENGINEERING CO

Is This Job for You?

BACKGROUND—Recent degree in mechanical or electrical engineering. About three years of design-engineering experience.

ABILITIES—Able to evaluate technical information on design techniques, new machines, components. Provable ability to write clearly and accurately. Should work well with people, have initiative and imagination, demonstrate creative as well as practical ability.

ENVIRONMENT—Cleveland, Ohio, with some out-of-town travel. As assistant editor on MD's staff of 21 engineer-editors. In Penton Publishing Company, a growth company, with 5 magazines and some 60 editors.

COMPENSATIONS—Salary comparable to that in industry. Chance to grow within the company. Unusual opportunity to broaden education, experience, and contacts. Stimulating work.

If this appeals to you not merely as a job but as the basis of a career, write at once (with all pertinent facts) to the Editor, MACHINE DESIGN, Penton Building, Cleveland 13, Ohio.

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS

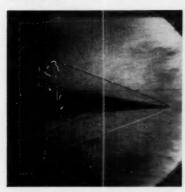


FROM CORNING

A LOOK AT TRANSPARENCY

One of the most useful qualities of glass is that you can see through it. In almost a century of experience, we've learned how to balance other useful properties of glass with transparency to give designers windows onto all sorts of worlds.

This small compendium on transparency-plus may give you an idea or two on how to get a look at whatever you'd like to watch.



The window through which this schlieren photograph was taken is 99.999+% fused silica, the most transparent glass for visible light ever made. Its extremely low coefficient of expansion gives it extremely high heat shock resistance. Couple these properties with a low refractive index variation and complete absence of physical flaws, and you have a window glass for such applications as this North American Aviation supersonic wind tunnel.

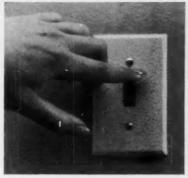
To study the impact of two opposing gas waves traveling at Mach 80, physicists at Boeing Laboratories take photographs through a 12-foot length of 6" O.D. Pyrex glass pipe. This is the same borosilicate glass we use in pipe for chemical and food processing plants and for drainlines and heat exchangers.



A quarter-inch polished plate of Pyrex brand infrared reflecting glass keeps this steel mill crane operator cool. The glass bounces as much as 93% of the infrared, yet transmits about 75% of the visible light.



This is a radiation shielding porthole which lets sailors on nuclear-powered submarines look directly, and safely, into the reactor chamber. It's made of a high-lead-content glass which stops gamma rays. For other hot cells, we've turned out shielding windows as big as five feet thick and nine tons heavy.



The mercury that makes this light switch noiseless is enclosed in a Pyrex® tube. Transparency makes preassembly inspection easy. Other features: the mercury can't corrode the glass; the glass serves as electrical insulation, and it can be sealed to metal.

A different kind of heat comes from a welding torch. This VYCOR® brand glass nozzle lets the welder keep a close eye on his work, but isn't affected by the heat. VYCOR brand glass is 96% silica, approaches fused silica in heat shock resistance.





Four-paned spaceports go into the Project Mercury capsules. Two panes of Vycor brand glass and two of aluminosilicate glass provide optical quality plus the space traveling necessities of great physical and thermal strength coupled with low weight.

AND FURTHERMORE ...

We have certain brochures and bulletins which explore more deeply the design possibilities of glass, with specific reference to transparency. We'll be glad to send you any or all of them upon receipt of the coupon.

CORNING	MEAN	SRE	SEARC	H IN	GLAS
CORNING	GLASS	WORK	S, 5209 C	rystal St., C	orning, H
Please send informati ☐ IR Reflecting Glass ☐ Fused Silica		Pipe F	lat Glasses	☐ VYCOR	
Name	***********	***************************************	***********	Title	*************
Company	*********************		************************	************************	***************************************
Street	*********************	**************	************	***************************************	
Oit.			7	State	

ANNOUNCING BOOKS PROGRAM:

THE HYDRAULICS-PNEUMATICS BOOK
Power Components

THE ELECTRIC CONTROLS BOOK
Switches, Relays and Timers
THE PLASTICS BOOK
THE MECHANICAL DRIVES BOOK

The four books to be published in 1962 will again cover subjects of vital interest to design engineers and will follow the same, easy-to-use and entirely reader-oriented style that was developed for the very first one. Each will have a Design Data Section devoted to significant selection and application information.

The contents will be authored by experts in industry, in Universities and associations, and Machine Design editors.

The second major section will consist of a Product

Directory, developed through direct mail cooperation with manufacturers and producers to insure the latest and most complete listings possible.

This entire series is designed to give you the most useful, the most complete and current reference information on important materials and components used in every-day design of products. These comprehensive reference manuals belong on the desk of every design engineer. Make sure these valuable books are coming to your department and are readily available.

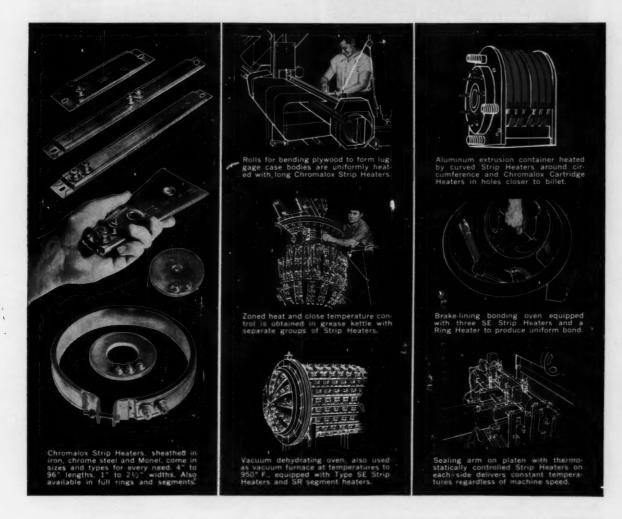


BASIC REFERENCE MANUALS FOR DESIGN ENGINEERS

A Penton Publication, Cleveland 13, Ohio

CHROMALOX ELECTRIC STRIP HEATERS

Versatile, dependable, uniform heat for your product or processing needs



Compact, metal-sheathed Chromalox Strip Heaters assure accurate temperatures, dependable around-the-clock service anywhere heat is needed for product or process. It is by far the most versatile built-in heat source available today. Easy to install—Chromalox Strip Heaters produce uniform and accurate temperatures with automatic or manual controls.

Low initial cost, low installation costs and low operating costs are among the many other advantages of using Chromalox Strip Heaters for heating tanks, platens, ovens, molds, moving parts, and similar uses. Over 500 standard sizes, shapes, ratings and terminal arrangements available immediately from stock. Get the full details now.

GET THE FACTS

Write for Industrial Processing Catalog 60, Comfort Heating Catalog F-975D, Infrared Catalog G-62.



EDWIN L. WIEGAND COMPANY
7575 THOMAS BLVD., PITTSBURGH 6, PA.



CHROMALOX ELECTRIC HEAT

PROCESS COMFORT

A series of unique articles outlining the steps in .



This 102 page volume includes practical data on:

- Measuring company needs in new-product development
- Developing and finding new-product ideas
- Evaluating new-product potentials
- Organizing engineering and research for product development
- Measuring progress in product performance

DESIGN

Reader Service, Penton Building, Cleveland 13, Ohio

(Remittance or Company Purchase Order must be enclosed with order.)

Send me____copies of

Planning New Products @ \$3.00 each

NAME

COMPANY

ADDRESS _____

ZONE ____ STATE____ 4_MAIL TODA

(Add 3% to orders for delivery in Ohio to cover State Sales Tax.)

This collection of 17 helpful articles details the necessary steps to the development and engineering of new products. Written by Dr. Philip Marvin, well-known management authority, this book is "required reading" for every engineer responsible for the development of new product ideas or the operation of a research program.

DESIGN

REPRINT

-MAIL TODAY

specify accurate instruments

TO MATCH THE QUALITY OF YOUR PRODUCTS

The quality of many a product is complemented by quality instrumentation. That is why many new machines come equipped with American Thermometers, Ashcroft Pressure Gauges, and American Temperature and Pressure Regulators.

We produce these temperature and pressure indicating and regulating devices in great variety for application by original equipment manufacturers. The reliable service these instruments give is also appreciated wherever industry must measure and regulate process temperatures and pressures.

Complete specifications available on request. Mail the coupon for catalogs.

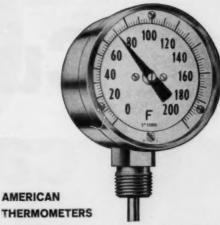


Fastest response is provided by these American Regulators because: 1) the stem can't bind and retard valve action; 2) a bellows seals off the stem and makes practical a non-leaking packless valve. They are self-operated – need no outside power to control temperatures and pressures. Maximum use is made of stainless steel and bronze. Regulator sizes: For temperature—½" to 4". For pressure—½" to 2". Operational ranges: temperatures as low as —15°F. to 50°F.; as high as 240°F. to 340°F. Pressure—250 lb. design.

MANNING, MAXWELL & MOORE, INC.



Gauge and Instrument Division • Stratford, Connecticut Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



Two outstanding characteristics of these American Bi-Metal Thermometers are 1) precision manufacture to assure sustained accuracy; 2) the unique Maxivision® dial that eliminates parallax errors. Stainless steel construction safeguards against corrosion. Hermetically-sealed models meet the severest service conditions. Dial sizes: 2", 3", and 5". Temperature ranges to suit the application. All types of connections. Stems to 24"; wells to fit all lengths.



These Ashcroft Steel Case Gauges are used on many portable compressors, pumps, and regular pressure lines. They are Bourdon-tube-equipped gauges in pressure, vacuum, and compound types. Brass movement is of precision design. Special heavy-duty movements also available. Pressures range from 15 psi to 600 psi. Dial sizes: 2", 2½", and 3½". Pulsation dampeners, gauge savers, needle valves, and other accessories available. Make your selections to fit the application. Other gauges in the Ashcroft line include Duragauge, Maxisafe, pneumatic receiver, recording, chemical, test gauges, and master reference gauges.

Manning, Maxwell & I East Main Street, Strat	The same of the sa
Send me the items checke American Bi-Metal Th American Thermomete Ashcroft Gauge Catale American Regulator B	permometer Catalog 155 er Catalog 100B og 300B
Name	
Title	
Company	
Address	
City/Zone	State

Cured of cancer!

In August 1950, Jack Oelker, a farmer in Urbana, Ohio, went to see his dentist complaining of a sore jaw. His "sore jaw" turned out to be cancer. Today, Jack Oelker is one of more than a million Americans who have been cured of cancer. Read why knowing the Seven Danger Signals of cancer may someday save your life!

JACK OELKER is 33 years old. Eleven years ago, he married Martha, his childhood sweetheart. Eleven years ago, five weeks after his marriage, Jack developed a sore jaw that didn't heal—and went to see his dentist.

That began the chain of events that led to the diagnosis of a bony tumor in the left jaw. Cancer. In September, 1950, Jack was admitted to University Hospital in Columbus, for surgery.

His doctor's verdict

Jack's doctor writes: "Since then, he has been rechecked at intervals and he has remained free of the disease. At the present time, he is able to carry out his norm activities, and shows no further evidence of tumor."

What are Jack Oelker's normal activities? Very much the same as yours and mine. The Oelkers like basketball games and picnics. They bowl.

The three Oelker girls, Susan, age 8, Sandra, age 6 and Carol Ann, age 4, have their father with them today because Jack Oelker acted promptly at



Jack and Martha Oelker with their children. You will see pictures of the Oelker family many times in 1961. They have been chosen as the American Cancer Society Poster Family—symbol of the fact that many cancers can be cured if detected in time.

the first sign of a "danger signal" and was properly treated in time.

There are two important ways that you can fight cancer. With a checkup and a check. An annual checkup—and a check to the American Cancer Society.

Where your money goes

Your check supports cancer research. Makes possible grants to research institutions. Provides fellowships to scientists engaged in cancer research. Educates the public to lifesaving facts about cancer. Helps maintain a program of service to the stricken.

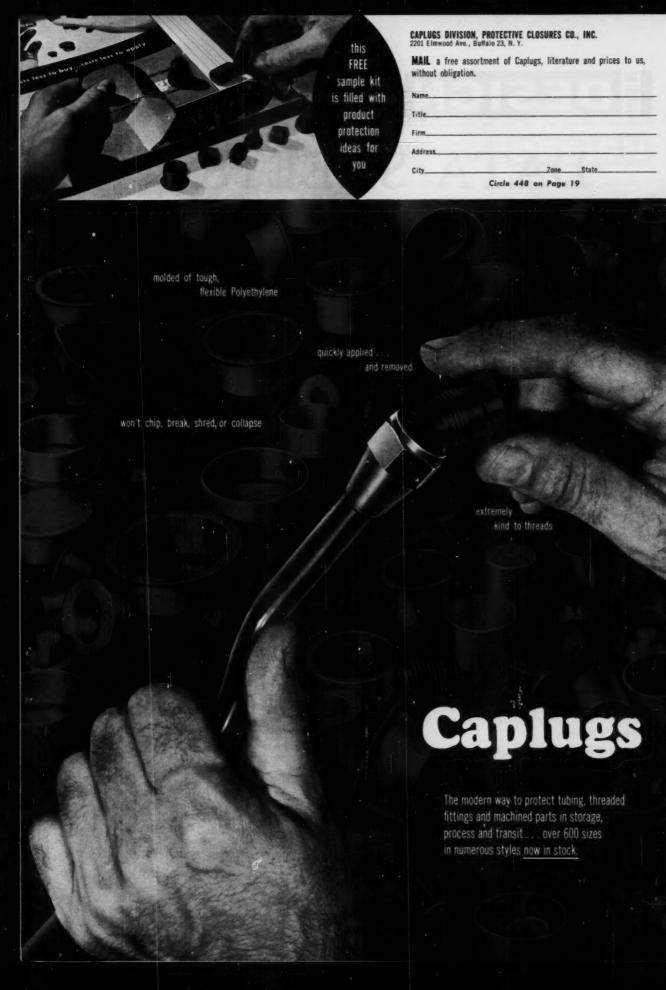
A checkup and a check. Worth remembering. And so are the 7 Danger Signals listed to the right.

The 7 Danger Signals of Cancer

- 1. Unusual bleeding or discharge.
- 2. A lump or thickening in the breast or elsewhere.
- A sore that does not heal.
 Change in bowel or bladder
- Change in bowel or bladde habits.
- 5. Hoarseness or cough.
- 6. Indigestion or difficulty in swallowing.
- 7. Change in a wart or mole. If your danger signal lasts longer than two weeks, go to your doctor immediately. Only he can tell if it is cancer.

AMERICAN CANCER SOCIETY







DATA SHEETS DATA SHEETS

DATA SHEETS

129 of those valuable nomograms, equations, charts, graphs and standards for calculating stresses, diameters, shock, and a multitude of day-to-day design decisions, are now available from MACHINE DESIGN.

DATA SHEETS

These Data Sheets are contained in five separate volumes—each containing the Data Sheets published in the respective years 1956 through 1960. Each volume contains a unique and worthwhile collection of engineering assistance for your personal reference file.

The 1960 volume contains a cumulative index of all published Data Sheets contained in the preceeding volumes.

PRICE \$2.00 each, including postage
Order your personal or departmental copy today.

Use this convenient form for prompt processing.	
Remittance or company purchase order must be enclosed with order.	
Add 3% to orders in Ohio to cover state sales tax.	
NAME	
COMPANY	
ADDRESS	
CITYZONE	
STATE	

DESIGN

Reader Service Department
Penton Building, Cleveland 13, Ohio
Please send me:

_____copies of the 1960 Data Sheets
(with the cumulative index)

____copies of the 1959 Data Sheets
____copies of the 1958 Data Sheets
____copies of the 1957 Data Sheets
____copies of the 1956 Data Sheets

46

Complete reprints of major articles now available from



USE THIS FORM TO ORDER YOUR COPIES TODAY!

Mumber Copies	Price Per Capy	Number Pr Copies	ice Per Capy
ELECTRIC MOTORS	\$1.00	TRANSACTIONS OF THE THIRD CONFERENCE	1.00
ELECTRONIC AND ELECTRIC POWE SUPPLIES	ER 1.00	ON MECHANISMS	2.00
FRICTION-CLUTCH TRANSMISSIONS	S 1.00	ENCE ON MECHANISMS	2.00
HUMAN-FACTORS ENGINEERING	1.00	TRANSACTIONS OF THE FIFTH CONFERENCE ON MECHANISMS	3.00
DIRECTORY OF MATERIALS—18th E	.,,,,,,	TRANSACTIONS OF THE SIXTH CONFERENCE ON MECHANISMS	2.00
ENGINEERING METALS	1.00	MECHANISMS FOR INTERMITTENT MOTION .	1.00
DESIGN MANUAL ON ADHESIVES	1.00	POLYDYNE CAM DESIGN	1.00
NONMETALLIC GASKETS	1.00	EVALUATING ENGINEERS	1.00
ADJUSTABLE SPEED DRIVES (Electrical, Mechanical, Hydraulic)	2.00	ENGINEERING MANAGEMENT	2.00
ADJUSTABLE-SPEED ELECTRIC-MOT		MEN AND MACHINES	1.00
AC MOTOR CONTROL	1.00	DESIGNING WITH TEFLON	1.00
INTERNAL COMBUSTION ENGINES	1.00	DYNAMIC SEALS AND PACKINGS	1.00
DESIGN FOR FATIGUE LOADING	1.00	MECHANICS OF VEHICLES	2.00
WHY MACHINE PARTS FAIL	1.00	TIPS AND TECHNIQUES—VOL. I (Drafting Aids)	1.00
SIMPLIFIED VIBRATION ANALYSISDIMENSION CONTROL IN DESIGN	2.00	TIPS AND TECHNIQUES—VOL. II (Engineering Aids)	1.00
HYDRAULIC SERVO FUNDAMENTAL	S Vol. I 1.00	PLANNING NEW PRODUCTS	3.00
HYDRAULIC SERVO FUNDAMENTAL	S Vol. II 1.00	DESIGN GUIDE FLEXIBLE COUPLINGS	1.00
HYDRAULIC SERVO FUNDAMENTAL	S Vol. III 1.00	INSIDE THE ENGINEER	1.00
QUALITY CONTROL METHODS	1.00	MOBILITY OF CROSS-COUNTRY VEHICLES	1.00
MULTIPLE CIRCUIT SWITCHES	1.00	HYDRAULIC LINES	1.00
ELECTRICAL CONNECTORS	1.00	1956-1960 DATA SHEETS (each)	2.00
PREVENTING FATIGUE FAILURES	1.00	THE FASTENERS BOOK	2.00
TRANSACTIONS OF THE FIRST CO	1.00	THE SEALS BOOK	2.00
TRANSACTIONS OF THE SECOND ENCE ON MECHANISMS	CONFER-	THE BEARINGS BOOK THE FERROUS METALS BOOK	2.00

MACHINE DESIGN

Reader Service Penton Building Cleveland 13, Ohio

TOTAL COPIES_____TOTAL ORDER \$____

Remittance or Company Purchase Order must be enclosed with order.

(Add 3% to orders in Ohio

ADDRESS ZONE STATE

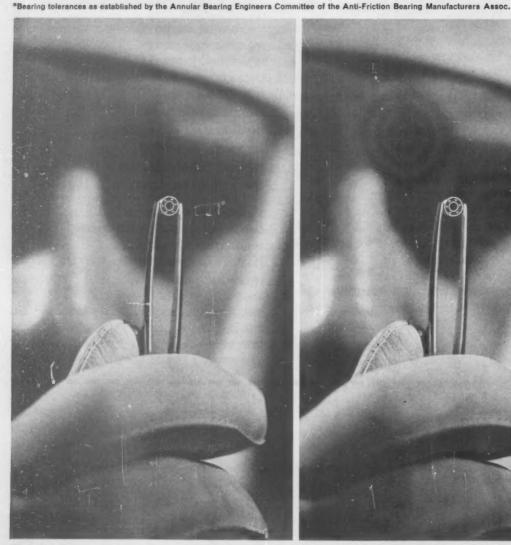
NEW-TWO LOW-COST MINIATURE BALL BEARING LINES

New Departure ABEC 3* and ABEC 5* miniature ball bearings now offer manufacturers of precision miniature potentiometers, gear trains, motors and similar precision products the opportunity to reduce bearing costs substantially.

New Departure ABEC 3 and ABEC 5 bearings can be used wherever the high precision and performance of ABEC 7 bearings are not required. They offer the engineer greater design versatility—he can select the most economical bearing for each application. Moreover, New Departure ABEC 3 miniature ball bearings can be used to upgrade products presently using precision sleeve bearings.

New Departure will continue to offer super precision ABEC 7 miniature ball bearings for your highly critical applications.

If you are planning a re-evaluation of your miniature bearing applications, it will pay you to consult the N/D Sales Engineer in your area. His assistance may help pave the way to reduced parts cost or enhance the quality of your product. For more information, write for booklet AST, NEW DEPARTURE, DIVISION OF GENERAL MOTORS CORPORATION, BRISTOL, CONN.

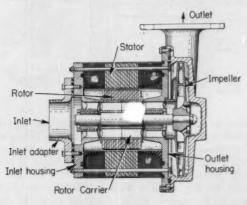


NEW DEPARTURE MINIATURE AND INSTRUMENT BALL BEARINGS

Patents

Fluid-Cooled Pump Motor

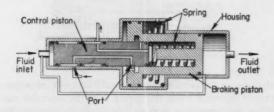
In a combination electric motor and centrifugal pump assembly the main portion of fluid flows through the motor and over the bearings while another portion passes through the air gap between the rotor and stator to provide fluid cooling. The pump motor has inlet and outlet members supported at each end of the housing and surrounded by fluid passages. The rotor



includes a rotor carrier having fluid passages corresponding to those of the housing end members. The main fluid flow enters at the inlet adapter, and then passes through the inlet housing, rotor carrier, and outlet housing into the intake of the impeller. Patent 2,993,449 assigned to Hydratomic Engineering Corp., Conn., by Raymond F. Harland.

Load-Compensated Brake

A variable-pressure source is automatically controlled to provide increased braking pressure with an increase in vehicle load. This function is achieved through the utilization of pressure developed in a fluid leveling



system. The system provides a pressurized-fluid (liquid or gas) suspension which maintains vehicle body at a predetermined level above the road surface. Pressure necessary to maintain the level increases as the vehicle is loaded, providing a volume of fluid under

PROXIMITY LIMIT SWITCHES

ALL STATIC—ACCURATELY LIMIT THE MOVEMENT OF MACHINES OR PARTS

Reliable—rugged—all static—corrosion resistant—can't wear out.

Not affected by oil mist, iron filings, sand, dust, dirt or water. Very successful in underwater applications. Tripped by any magnetic material. Has passed Navy shock and vibration tests (MIL-S-901B) and (MIL-STD 167).

Proximity limit switch installations include only three

- Sensing head located where magnetic pieces will actuate the element when brought within the predetermined trip distance;
- Control element picks up the signal from the head and drives static control components, relays or solenoids;

 115 v, 60 c, supply line and head-to-element lead. Normally each sensing head requires its own control element, although in special applications up to six heads can be used on a single element.

OPERATING PARAMETERS:

Two operating distances: Adjustable ½"—½"; ¼"—2". 5-20 operations per second. Response time, 25 milliseconds. Sensitivity to turn off: 20% at maximum trip distance; 5% at minimum trip distance. Control element output: 8 w, 24 v d-c at 335 ma, 60 cps.

For specific or test applications, send your order or request for further technical information direct to General Purpose Control Dept., P.O. Box 2025, Buffalo 5, N.Y.

You can be sure . . . if it's Westinghouse.



Westinghouse Electric General Purpose Cont	orporation I Dept., P.O. Box 2025, Buffalo 5, N.Y.
	ol information on the following units 806G01 □ 317C259G01 □ 614C002G01
Name	
Company	
Address	
City	Zone State

SYNFLEX PRESSURE HOSE*

now handles them all





WHAT'S YOUR PROBLEM?

Grease
Anti-Freeze
Freon-12
Freon-22
Skydrol
Sunlight
Abrasion

*Synflex Pressure Hose is an entirely new—and fully proven—departure in pressure hose design and manufacture. There's nothing—absolutely nothing—like Synflex Pressure Hose.

Synflex Pressure Hose construction is comprised of a precision-drawn special polyamide formulation core tube, a tough braided plastic covering for burst resistance, and an extruded polyamide outer sheath to form an homogenous tube structure. Result: lightweight, flexibility, chemical and abrasion resistance.

Synflex Pressure Hose is competitively priced, more than meets all requirements of SAE Specification 100R1. Write for literature and sample length of Synflex Pressure Hose TODAY.

A-2129A



SYNFLEX

Products Div.

Samuel Moore & Co.

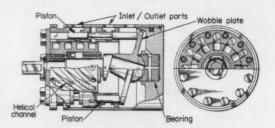
Mantua, Ohio

NOTEWORTHY PATENTS

pressure which varies directly with the load of the vehicle. The fluid is directed to a power booster (shown). From the booster, the variable fluid pressure is applied to the brakes. Patent 2,991,130 assigned to Thompson Ramo Wooldridge Inc., by Achilles Charles Sampietro.

Fluid Motor

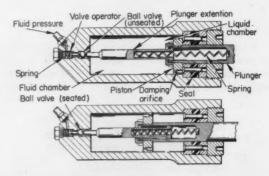
In a wobble-plate type motor, pistons have the dual function of converting fluid pressure into mechanical motion and acting as valves to control fluid flow to and from cylinders. The cylinders are parallel to the shaft and are arranged in groups. The pistons in each group control the fluid flow to and from the cylinders of the particular group. Each group of pistons is in effect a



motor in itself. For example, in a motor having twelve cylinders there are three groups of four cylinders each. The cylinders of each group are spaced at 90 deg intervals and are connected by helical fluid channels. Each piston controls the fluid flow to a cylinder disposed 90 deg from it. Patent 2,994,306 assigned to Sprague Engineering Corp., Gardena, Calif., by Carlos B. Livers.

Temperature-Compensated Liquid Spring

A ball-valve assembly is automatically operated during liquid-spring movement to compensate for changes in fluid volume. Such volume changes are caused by

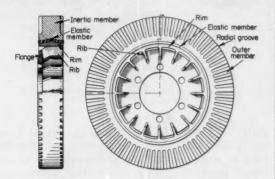


changes in temperature or by liquid losses. Compensation is provided when the spring is in the extended position by permitting a free flow of fluid between the fluid chamber and a constant external pressure source. Thus the desired pre-charge pressure is maintained at all times. A spring within the plunger forces the plunger extension to the left to close the valve when the plunger moves from the extended position. The

device is particularly suited for use when wide temperature ranges are encountered because of altitude and climatic changes. Patent 2,992,816 assigned to Cleveland Pneumatic Industries Inc., Cleveland, Ohio, by William A Gail.

Torsional-Vibration Damper

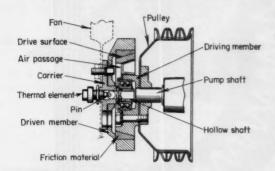
In a damper assembly, an elastic member is positioned between concentric member and outer (inertia) members. The curvature of the concave and convex surfaces provides that torsional forces between the inner and outer members produce a uniform torsional stress throughout the elastic member. Also, the cur-



vature provides that axial forces between the members cause compression of the elastic member, thus minimizing shear stresses. The maximum diameter of the outer margin of the inner member is made slightly less than the minimum diameter of the outer member so that the parts can be readily assembled. Patent 2,992,-569 assigned to Schwitzer Corp., Indianapolis, Ind., by Ralph H. Katzenburger.

Thermally Actuated Slip Clutch

The amount of torque transmitted to an automobile fan is automatically controlled by a thermal element in relation to the temperature of the cooling water.



When the air moving past the thermal element is heated, the post of the element extends against a pin. This force is transmitted to mating conical friction surfaces, increasing the pressure of engagement and, consequently, the torque transmitted by the contact faces. The thermal element is supported by a carrier and re-

IT PAYS TO KNOW Perma-Nuts



SIMPLER PLASTIC-TO-METAL ATTACHMENT

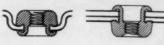
"Knowing about the TRS Perma-Nuts when our electric chord organs were designed enabled us to make an almost 'impossible' assembly . . . easily, at low cost and at a high production rate," states Emenee Industries, Inc., New York, world's largest manufacturer of musical toys. "The problem was to attach a reed housing, made of high impact styrene, to a steel turn plate with a threaded fastener. Tapped threads in the styrene would have been subject to stripping. Design of the parts allowed inadequate clearance for a nut, and handling a nut in the semi-blind location would be very difficult, if not impossible."



The ideal solution was found in Perma-Nuts, automatically fed and set (just like rivets in metal) by standard TRS riveting machines, airpowered to afford controlled "cushioned" action which clinches Perma-Nut to the styrene without breakage.

Whether your attachments are made to metal or plastic, it will pay well to see if Perma-Nuts will do the job. Ample threads in the head for holding power. Sharp serrations under head act as a lockwasher. Head size is same as hex nut of same size. Nine thread sizes, #3-48 to ½4-28 available in steel, brass, aluminum. SEND for Catalog showing many ways to use these versatile helpers. Or look in "Yellow Pages" for nearby TRS man to give you facts or help.







FLUSH MOUNTED NUT PLATE

NUT & RIVET

NUT & RIVET & SPACER



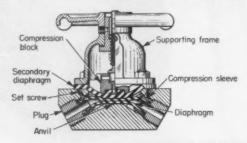
TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASSACHUSETTS

motely located from the driven member which has apertures to permit the passage of cooling air. Therefore, the heat generated by the friction material has no substantial effect on the operation of the thermal element. Patent 2,990,045 assigned to Lipe-Rollway Corp., Syracuse, N. Y., by Robert S. Root.

Diapinch Valve

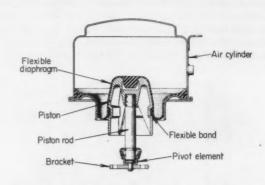
A secondary diaphragm in a pinch valve for handling hazardous fluids prevents direct contact of the main conduit with the pinching element to lengthen conduit life. Also, the diaphragm forms a sealed chamber



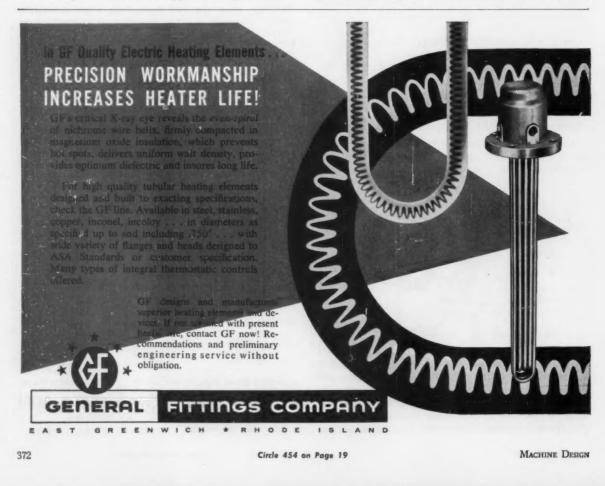
which may be filled with decontaminating fluid. Then, if the inner tube ruptures, any organisms passing into this chamber are killed or rendered harmless by the fluid. Compression forces are applied through the secondary diaphragm which fits over a central opening in the valve frame and held in position by the bellshaped supporting frame. Patent 2,994,337 assigned to the United States of America as represented by the Secretary of the Army, by Robert R. Freeman.

Self-Cleaning Air Spring

To prevent a build-up of harmful coatings on an air spring, an annular recess is formed in the piston skirt to house an elastomeric band. The outside diameter



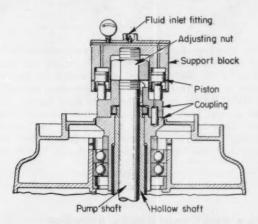
of the band is slightly greater than the outside diameter of the piston skirt. During normal oscillation the band is alternately exposed and overlapped by the flexible diaphragm. Thus, any coating deposited on the band during momentary exposure to the atmos-



phere is subsequently overlapped by the intermediate portion of the diaphragm. This action flexes the band to prevent permanent encrustation and prolongs diaphragm life. Patent 2,988,353 assigned to General Motors Corp., Detroit, Mich., by Eric R. Dietrich.

Shaft Adjusting Mechanism

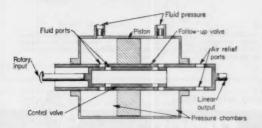
Axial adjustment of a vertical pump shaft can be varied hydraulically while the pump is running. Shaft position is controlled by an adjusting nut which rests upon a seat formed by the upper surface of the shaft coupling. To provide rotation of the nut without friction a fluid-operated mechanism is provided for lifting the pump shaft. The mechanism, which rotates with the shaft, consists of a U-shaped cylinder block, the



legs of which extend downward along opposite sides of the shaft. Two hydraulic pistons are contained within the block. Because the coupling cannot be moved axially, fluid pressure applied to the pistons causes the U-shaped block and shaft to be elevated. In this position the adjusting nut can be readily rotated upward or downward when the pump is stopped. Patent 2,993,448 assigned to U. S. Electric Motors Inc., Los Angeles, Calif., by Albert J. Carey.

Rotary Linear Signal Converter

Conversion of a rotary input signal to a linear output is provided by a double-acting piston and rotary valve arrangement. The rotary sleeve-valve assembly



releases fluid (air) from either side of the piston, creating a pressure drop to produce linear motion. The



FASTENERS-

Sorvice ___ 40 sales representatives all over the country for prompt, fast service.

Reliability—Quality controlled by the oldest established lock nut manufacturer in the U.S.

Stock — Large inventories to ensure out of stock delivery on all catalogued items.

Speed production and lower costs on your products with this GRIP NUT family of GRIPCO FASTENERS. Qualified fastener engineers are available for consultation on all your assembly problems. Consult the yellow pages in your phone book under "GRIPCO" for the one nearest you.

Other Gripco Products:

- Brass Toplock or Centerlock nuts.
- Miniature weld and clinch nuts, with or without lock.
- Toplock and Centerlock Hi Nuts.
- Standard Semi-finish full and jam nuts.
- Stainless Steel lock, weld and semifinish nuts.
- Cold formed special nuts or parts to print.

Send for samples and NEW CATALOG today



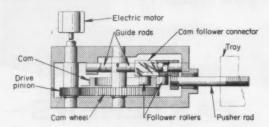
GRIP-NUT COMPANY

103 MAPLE AVE. SOUTH WHITLEY, INDIANA Phone: South Whitley 723-5111

Subsidiary of Heli-Coil Corporation, Danbury, Conn. control valve has a pair of ports on each side of the piston which is attached to a follow-up sleeve member with ports located adjacent to the control valve ports. The follow-up ports are elongated and in the form of a slot. Thus, rotation of the control member in either direction causes overlapping between certain adjacent ports, releasing the fluid in the chamber on the corresponding side of the piston. Patent 2,992,633 assigned to Thompson Ramo Wooldridge Inc., Cleveland, Ohio, by Paul M. Stiglic.

Inertial-Drive Conveyor

A drive cam which imparts oscillatory movement to a conveyor tray is phased to retract with a "snap action" to, in effect, move the conveyor surface from

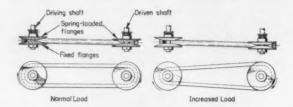


under the material. This snap-retraction phase consists of a quick initial retraction of the conveyor followed by a gradual retraction which merges into a

rest phase. Thus, inertial force imparted to the material exhausts itself by the forward movement of the material over the conveyor surface. Rectilinear movement of the tray is provided by a cam follower and connector assembly. Patent 2,991,872 assigned to Mathews Conveyer Co., Ellwood City, Pa., by Thomas F. Keegan.

Self-Regulating V-Belt Drive

Two variable-pitch sheaves mounted in an offset arrangement provide automatic regulation of drive ratio in response to variations in load without auxiliary control equipment. The sheaves are of equal diameter



with one fixed flange and one movable spring-loaded flange. When the sheaves are mounted, the fixed flange of the driven pulley is displaced from the belt plane of the driving pulley not more than the width of the V-belt in the direction of the fixed flange. Under normal load conditions, the belt assumes equal pitch-diameter positions on both sheaves. As load increases, the combined action of belt friction, belt tension, and the offset sheave arrangement causes the

AT WM. A. FORCE

ENGRAVING IS OUR BUSINESS

Since 1875, whenever engraved parts are specified, the call goes out for the Force representative. Force manufactures engraved components to your particular requirements, such as numbering units, wheels, type, etc.—from the most complex assembly in elec-

tronic scanning to a single part. For many firms, engraved components by Force specialists has meant increased production rates, fewer rejects, all reflected in savings. Force products are turned out by the latest, automatic high-speed machines.



Tell us your needs and we will be happy to send you further information.

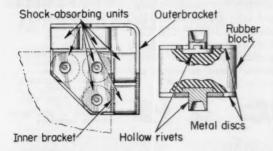
FORCE 215 Nichols Ave.
Brooklyn 8, N.Y.



belt to move toward maximum pitch-diameter position on the driven sheave and minimum pitch-diameter position on the driving sheave. Result is a change in speed ratio. For decreasing load, the "belt-shifting" action is reversed. Patent 2,994,228 assigned to Osborne Associates, Los Angeles, Calif., by Philip S. Osborne.

Three-D Shock Mount

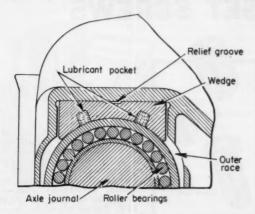
A shock mount for corner-supporting of structures provide high absorption damping in all directions. It comprises a three-face outer bracket and a nested inner bracket of similar configuration with rubber shock-absorbing units mounted between the two brack-



ets at each face. The bracket faces are at right angles to each other. Eight mounts are used with a box-type structure for vibration and shock isolation. Patent 2,993,673 assigned to Servo Corp. of America, New Hyde Park, N. Y., by Luis F. Villar.

Protective Bearing Lubrication System

A safety device extends the operating range of antifriction roller bearings and warns of overheating by smoke and odor given off by melted grease. Hightemperature grease in wedge mounting adapter pockets melts at a predetermined temperature to lubricate the

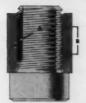


outer race. This supply of lubricant prepares the outer race to rotate in the wedge and converts the unit to a plain bearing. A relief groove in the top of the wedge spreads the load over a large circumference. Patent 2,994,566 assigned to The Timken Roller Bearing Co., Canton, Ohio, by Thomas C. Keller.

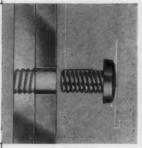
This is a LONG-LOK Self-Locking Screw. It is a onepiece reusable fastener, heat, vibration, impact and shock resistant.



It is vibration resistant because the resilient, reformable insert (A) acts as a wedge between the male and female threads, causing a metal-to-metal drag (B).



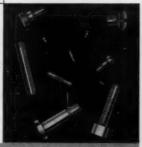
LONG-LOK Self-Locking Screws are flush protruded and pass through normal clearance holes with finger pressure. No special clearance holes are required.



LONG-LOK Self-Locking Screws save time and money because they eliminate safety wire (and head drilling), and lock washers. They also save weight.



LONG-LOK Self-Locking Screws are available for aircraft, missile and commercial applications. They meet MIL-F-18240 Specifications and can be head marked for self-lock identification.



Write for Catalog LL-81



LONG-LOK CORPORATION

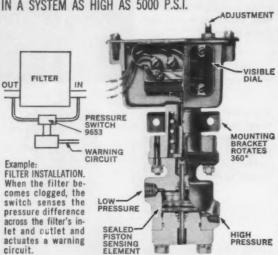
101 REDWOOD AVENUE . LOS ANGELES 66, CALIF. EXmont 1-7128 - TWX S MON 7146

LONG-LOK EASTERN CORPORATION
68 Urban Ave., Westbury, L. I., N.Y., EDgswood

Licensees and Representatives in Principal Cities

NEW PRESSURE DIFFERENCE SWITCH

SENSES A LOW DIFFERENCE OF 10 P.S.I. EVEN IN A SYSTEM AS HIGH AS 5000 P.S.I.



The new Model 9653 is constructed to sense a difference from 5 P.S.I. to 140 P.S.I. between two pressures. A sealed piston sensing element actuates an electric circuit on increasing or decreasing of a predetermined pressure difference. It is applicable to oil systems ranging from 50 P.S.I. to 6000 P.S.I. working pressure. A high proof pressure rating of 9000 P.S.I. is your protection against damage from surges and shock loads. Field setting is simplified by means of an external adjustment screw and visible dial.

WE BUILD IN

WE DON'T USE

RUGGEDNESS

Can take surges-(High proof pressures) Continuous operation— (Millions of cycles) No sticking-

(in dirty fluid)

LINKAGES & BEARINGS

Which wear quickly -(cause settings to drift and switch to fail)

LABOR & MATERIAL SAVINGS

No return drain piping-(Sealed piston) Mounts where convenient (Operates in any position, Not sensitive to vibration)



UNSEALED PISTONS

Which add to your installation cost (return piping). Are critical to dirt-(pistons get stuck).

Ask for new pressure switch handbook and catalog '61-'62





LONG LIFE

with

CARBON-GRAPHITE

BEARINGS . RINGS . GUIDES

Now you can obtain all the advantages of carbon-graphite PLUS the added strength and long life of metal reenforcement, METALLIZED CAR-BON components are being successfully used in pumps, meters, ovens, conveyors and processing equipment.



PROPERTIES

- . SELF LUBRICATING
- . OIL FREE
- LOW COEFFICIENT OF FRICTION NON-CONTAMINATING
- · CORROSION RESISTANCE
- · CURRENT CARRYING
- EXTREME TEMPERATURES
 —100° F to 1000° F
 WILL NOT WARP, SWELL,
 STICK OR GUM
- OPERATES AT HIGH SPEEDS DRY OR SUBMERGED



Our engineering department will gladly make prompt recommendations

METALLIZED CARBON COMPANY 19 SOUTH WATER ST. OSSINING, NEW YORK

Circle 459 on Page 19

Simplify design, purchasing, production with

MOORE





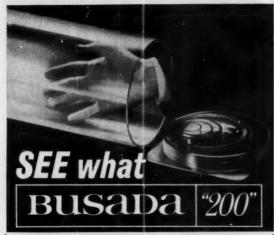
*PDQ means price, delivery, quality. And you get all three with Moore Set Screws. The PRICE is right. Ample production capacity and inventories assure fast DELIVERY. And rigid control standards guarantee there's no skimping on QUAL-ITY. Specify Moore Set Screws and be sure. Dependable quality for over 80 years.

Send for catalog

MOORE SET SCREWS

George W. Moore, Inc.

since 1880 93 Beaver St., Waltham 54, Mass.



TRANSPARENT TUBING can do for your product

Extruded Tenite butyrate tubing in an exceptionally wide range of sizes. Smallest is 0.750° O.D. x $1/16^\circ$. . . O.D.'s go up to $8\frac{1}{2}^\circ$, wall thicknesses to $\frac{1}{4}^\circ$. . . 84 standard sizes in all . . . custom sizes available on special order. Crystal clear, tough; highly machinable, highly dielectric, highly usable. Get the full story on this versatile plastics tubing . . transparent BUSADA "200." Send for descriptive brochure today.

BUSADA MANUFACTURING CORPORATION Specialists in Transparent Plastics Tubing and Pipe

32-31 Downing St. • Flushing 54, N. Y. • LEnox 9-3431

Circle 461 on Page 19

Designer's Fact File from DENISON

PUMPING UNITS



Vertical-type design with all components mounted as a single unit on top cover for easy access. Reservoir base with capacities from 5 to 35 gallons. Adjustable relief valve provides simple control of maximum pressure. Standard NEMA, C-base type motor. Available with optional accessories—coolers, filters, gauges and temperature gauges. Volume capacities from one to 18 gpm, pressure ranges from 800 to 3000 psi.

Write for full details in Bulletin PU-3.

DENISON ENGINEERING DIVISION American Brake Shoe Co.

1240 Dublin Road . Columbus 16, Ohlo

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

Denison and Denison HydrOLLics are registered trademarks of Denison Eng. Div., ABSCO

Juda Ollica

Frequency Converters

IMMEDIATE DELIVERY ON MANY RATINGS



High Conversion Efficiency
Low Audible Noise
Compact Unit-Shell Design
Light-weight construction
Simple, rugged, virtually maintenance-free
High Overload capacity
Modestly Priced (from \$415)

Catalog No.	Input Phase	Rating KVA	Output Phase	Speed RPM	Length	Width	Height	Weight lbs.
30-021	1	.15	1	3600	11"	10"	8"	40
30-001	1	.25	1	3600	11"	10"	8"	43
30-002	1	.50	1	3600	11"	10"	8"	51
30-003	1	1.00	1	1800	16"	14"	12"	110
30-004	1	.25	3	3600	11"	10"	8"	42
30-005	1	.50	3	3600	11"	10"	8"	51
30-006	3	.75	3	3600	11"	10"	8"	51
30-007	1	2.00	3	1800	16"	14"	12"	126
30-029	3	2.50	3	1800	16"	14"	12"	165

ALL UNITS SOLD WITH MONEY BACK GUARANTEE

Georator Corporation

FAIRVIEW ROAD AND TUDOR LANE . MANASSAS, VA.

Phone-EMpire 8-2101-Call us collect



CORBIN LATCHING DEVICES

The Catches shown here represent only a few types of latching devices available in the full CORBIN line . . . catches available for metal, wood or plastic installation.

Why not call on our experience to help you in choosing the best latching device or hardware element for your application?

No. 15642*

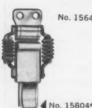




No. 15642 Draw Pull Catch:-Heavy-duty steel or brass construction in many finishes and varieties of strikes. Locking ears for padlock security. (No. 15642S available with single locking ear for padlocking.)

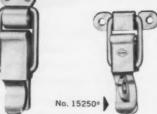
No. 15834 Compression Spring Draw Pull Catch:-Carbon steel with stainless steel spring cover and cradle. Flush mounting, Concealed springs. Many finishes, Approximately 60-lb. load at ½" max. deflection. Withstands 600-lb. pull test. Meets military specifications





No. 15641*



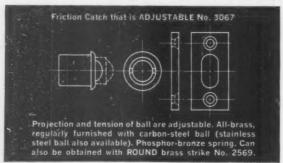


No. 15804 Heavy-Duty Draw Pull Catch:-Carbon steel with stainless steel connecting links. Approximately 100-lb. load at 1/8" maximum deflection. Many strikes available.

No. 15641 Draw Pull Catch:-Heavy-duty, steel or brass construction. in many finishes. Variety of strikes available.

No. 15250 Draw Pull Catch:—Steel or brass construction, in many finishes. Locking ear for padlock security. Variety of strikes available.

*Can be furnished with mounting holes, or without for spot welding.



These and many other items complete the extensive CCL line. Write for further information.



CORBIN CABINET LOCK DIVISION THE AMERICAN HARDWARE CORPORATION NEW BRITAIN. CONNECTICUT

Now... 7 Sizes of Gould Solenoid Valves

bear this seal



They're Types Q and Q-1 in all these sizes: 36" • 1/2" • 34" • 1" • 11/4" • 11/2" • 2"

Fully Automatic . Normally Closed . Packless 2-Way . Piston-Pilot Operated . Bronze Body

TYPE Q General purpose for air and water at pressures from 5 to 400 psi; temperatures to 250° F. . . . and steam at pressures to 15 psi; temperatures to 250° F.

TYPE Q-1 For steam at pressures from 5 to 150 psi, and temperatures to 365° F.

TYPICAL USER NET PRICES . F.O.B. FACTORY

Coils of both types are guaranteed unconditionally for a full year

Write for FREE Bulletin on Our Full Line of Solenoid Valves!

TYPE Q-1 TYPE Q SIZE 1 to 5 100 to 49 1 to 5 22.00 19.25 29.10 25.46 28.96 3/4" 26.00 22.75 33.10 35.00 43.00 30.63 37.63 42.10 50.10 36.84 43.48 11/2" 66.00 57.75 73.10 63.96

J. D. GOULD CO. . 4707 MASSACHUSETTS AVE. . INDIANAPOLIS 18, IND

VELVETROL

Circle 465 on Page 19



water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily-without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—without the use of pipe dope. Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

For further information write



RU-SEAL DIVISION

7N016 York Rd., Bensenville, III. 'Miller Fluid Power" is also a Div. of Flick-Reedy Corp.





5







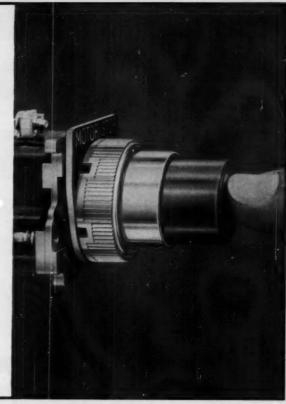
New! Versatile Cutler-Hammer oiltight pushbuttons let you make any station you want

The new interchangeability built into these operators lets you create the station you want from a complete selection of Cutler-Hammer pushbuttons. Get them in one hole or base mounting, 6 bright colors. Thirty different circuit arrangements can be made in hundreds of varieties of stations in standard arrangements of up to 25 elements. Get up to 8 circuits on one pushbutton. They take 40% less back-panel space than next smallest unit so you get more control in less space. Get facts in PUB. LO-104-S243.

WHAT'S NEW? ASK ...

CUTLER-HAMMER

Cutier-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiery: Cutier-Hammer International, C. A. • Associates Canadian Cutier-Hammer. Ltd.: Cutier-Hammer Mexicana, S.A.



Circle 467 on Page 19

NOBODY STEALS MY DRIV-LOK CATALOG!

It's the most complete reference I have on grooved pins. Not only tells me about the extensive line of diameters, lengths, groove arrangements, steels, aluminums, brass, bronze and other pin metals available from Driv-Lok, but special pins as well.

It's got factual information on drilling procedures, tolerances, weights per thousand, minimum shear values for various metals, recommended pin diameters for various torque values, and a host of typical applications.

Those applications are great. Give me all kinds of ideas. Mostly how to get the best fastening job for the least amount of time and money.

Don't get hung up...from stealing or a tough fastening problem. Send for your Driv-Lok catalog today!



DRIV-LOK SALES CORPORATION

715 Park Avenue, Sycamore 1, Illinois

GRC tiny parts

Die Cast
ZINC ALLOY
Molded
PLASTICS



Molded Nylon, Delri & Other Engineering Thermoplastics



Gears & Pinions



GRC's unique high speed, automated methods give you high quality, uniformly accurate small parts in die cast zinc alloy ar molded Delrin, Nylon and other engineering thermo-plastics . . . at low cast. GRC experience and exclusive techniques open the way to new design freedom, new production and assembly shortcuts. Write, wire, phone NOW for samples and detailed bulletins. Send prints for prompt quotation.

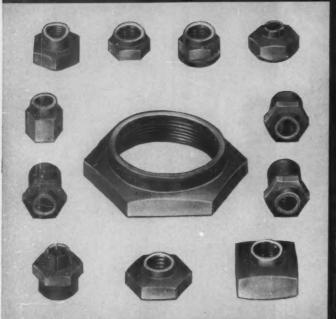
NO MINIMUM SIZE! Maximum aizes: Zinc Alley—2" long, ½ ez. Plastic—1%"



GRIES REPRODUCER CORP.

World's Foremost Producers of Small Die Castings 32 Second St., New Rochelle, New York • NEw Rochelle 3-8000

SPECIAL LOCKNUTS ... that solved fastening problems



As the largest specialized nut manufacturer in the world we are constantly developing new methods and products for this phase of assembly in industry . in the field of locknuts we have made spectacular progress. Besides standardized hexagon "Conelok," "Huglock" and "Marsden," sizes #10—3" of ferrous and non-ferrous materials, we provide many special application nuts, upon a basis of these designs . . . a few of which are here shown . . . Our sales and engineering departments are available to help you salve your fastening problems . . . Send for 12-page condensus catalog, it includes complete specifications of our entire product, as well as engineering data. We also have an one hundred and forty four page catalog where more comprehensive information is required.

Manufacturers of Standard and Special ferrous and non-ferrous Hexagon, Square and "12 Pointer "Conelok," "Huglock" "Marsden" locknuts



NATIONAL MACHINE PRODUCTS COMPANY

an \$P\$ company 44250 UTICA ROAD UTICA. MICH

Circle 470 on Page 19



NEW AIR-CHAMP BRAKES*

STOP SURE! For stopping rotating parts! PANCAKE DESIGN takes less room—MOUNT ANYWHERE torque arm or universal. 3 low-inertia models handle up to 4,300 inch lbs. torque. FORCED DRAFT COOL-ING dissipates heat fast; remote friction surface position guards against heat buildup and brake "fade." Control with static air pressure. Low cost! Ask about "Air-Champ" clutches! Write for brochure! *Patent pending

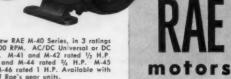
HORTON MANUFACTURING CO., INC. 1179 15th Ave. S.E., Minneapolis 14, Minn.



Please direct inquiries to advertiser, mentioning MACHINE DESIGN

FHP motors...engineered

especially for your product



The new RAE M-40 Series, in 3 ratings at 5000 RPM. AC/DC Universal or DC Shunt. M-41 and M-42 rated ½ H.P. M-43 and M-44 rated ½ H.P. M-45 and M-46 rated 1 H.P. Available with

RAE engineers are recognized specialists in solving difficult FHP motor applications. By careful analysis and testing of your product, they can save you time and money in selecting the right motor.

and money in selecting the right motor. RAE offers outstanding service and quality in a large variety of motors. Available in voltages up to 250, and up to 1/2 H.P. (higher for intermittent duty) with many gearhead motor combinations. Find out how RAE motors can improve your product and reduce costs as they are doing for other leading manufacturers.

**Send for the "RAE" Engineering Data Sheet. It will help you supply the data necessary for recommendations and prices.



AC/DC Universal • DC Shunt Wound • DC Series Wound • Gear Reduction Motors • Governor Controlled Motors • Motors for Rheostat Control • Motors for Electronic Control • Permanent Magnet Motors and Gearmaters.



Room Saving Drawer Units!

WOOD PLAN FILE

Do you need extra drawer space but are short on room? Mayline wood plan files can be readily attached to Mayline wood 4-Post tables—you get 3 extra drawer combinations at a saving of floor

For complete information on these and other Mayline drafting furniture and equipment write for your copy of Catalog #11, or consult your local dealer.

MAYLINE CO., INC.

601 NO. COMMERCE ST. SHEBOYGAN, WISCONSIN



WOOD 4-POST TABLE

MAYLINE. Circle 472 on Page 19



Pot. #2,841, 174

A complete line: ¼", ¼", ¼", ½", and ¾" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

TYPICAL APPLICATIONS



and do Controlling Single Acting Cylinder



2925 GRANT STREET ELLWOOD (Chicago Suburb) ILLINO 15



Hermetic ... They're Leakproof! **NEW 'BUFFALO'**

PUMPS with self-adjusting bearings

Now, from Buffalo Pumps, a leakproof line of totally enclosed hermetic pumps so simple in design they can be taken apart and reassembled with open end wrenches and a screwdriver.

Designed for the chemical, petro-chemical, atomic energy, and marine industries, the new Can-O-Matic's are the most practical, durable and easily maintained pumps in the hermetic field.

Long-life bearings represent a great new advance in canned pump design. Lubricated by the liquid being pumped, they absorb both radial and axial thrusts...automatically compensate for bearing and journal wear. Toxic or volatile liquids cannot escape . . . air cannot leak in.

Thirteen sizes with 1" to 5" discharges are now available for a wide range of applications. Standard units with stainless steel rotor cans are designed for 120 psig and 40° through 250° F. operations. Special models are available for higher pressures and temperatures, and a variety of dangerous corrosive liquids.

For additional information and specs, contact your resident Buffalo representative, or write direct for Advance Bulletin 977.



BUFFALO PUMPS DIVISION

BUFFALO FORGE COMPANY Buffalo, New York

Canada Pumps Ltd., Kitchener, Ont.

ment to move, heat, cool, a humidify and clean air a humidity an other gases.

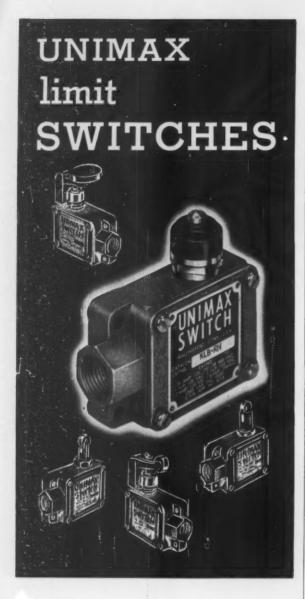




'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.



Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.



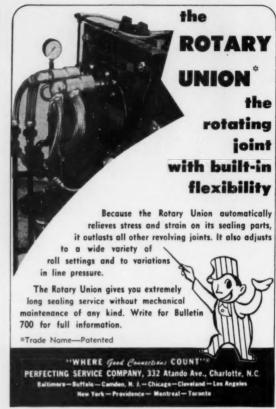
In heavy-duty and general-purpose styles, these Unimax switches are suited to a wide variety of control requirements.

Heavy-duty Type KLB-RH (above) has UL rating of 1 hp 125 v. a-c; 2 hp 250 v. a-c; 20 amperes 125, 250, 480 v. a-c; 10 amperes 125 v. a-c lamp load.

Various sizes, mounting styles, and actuators are available. Write for Catalog 123 that describes the complete Unimax line.

Local distributors now stock Unimax switches for your convenience.





Circle 476 on Page 19



"SPUN END" CONSTRUCTION—Eliminates weldments in areas of high stress concentration, a major source of fatigue, warping and trouble.
"Spun End" construction allows the placement of maximum metal thickness at end plate bore reducing unit pressures of radial loads while providing thin plate flexibility to accommodate shaft deflections.

CURVE CROWN DESIGN
— Accurately formed
CURVE CROWN on outer
ends of rim eliminates
conventional center peak
— a high point for belt
stretch and wear—while
increasing belt training
effect more than 100 %.



SQUEEZE LOCK HUB—Design effectively transfers loads from rim to hub and from hub to shaft. Hub provides for full torque transmission without the use of keyways and eliminates distorting loads against pulley "Spun End." The SQUEEZE LOCK Hub exerts locking forces in two directions—to both shaft and pulley end plates—through a self-contained hub.



WRITE FOR BULLETIN 1160

PRODUCTS DIVISION
STEPHENS-ADAMSON MFG. CO.

18 RIDGEWAY AVENUE • AURORA, ILLINOIS
PLANTS LOCATED IN:
LOS ANGELES, CALIF. • CLARKSDALE, MISS.
BELLEVILLE, ONTARIO • MEXICO CITY, D. F.



Combine Monoball® Engineering Advantages with Life-Time Lubrication

Design engineers in many industries are specifying new "DYFLON"® SELF-ALIGNING and SELF-LUBRICATING SPHERICAL BEARINGS for these 5 major reasons:

- 1. LOWER COEFFICIENT OF FRICTION
- ...ideal where lubrication is impossible or undesirable.
- 2. WITHSTAND EXTREME VIBRATION
- ... perfect performance under shock load conditions.
- 3. WILL NOT "COLD-FLOW"
- ... even under extreme load conditions.
- 4. IMPERVIOUS TO KNOWN CHEMICAL SOLVENTS
- ...eliminates corrosion problems.
- 5. FAIL-SAFE ... due to "Monoball" design.

Request Engineering manual No. 551.

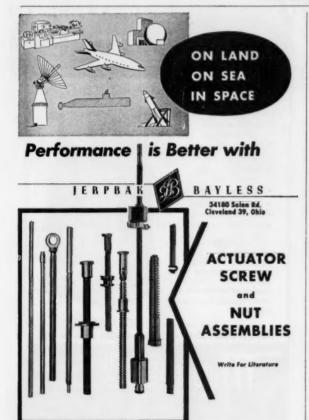
In addition, due to their two-piece "MONOBALL"® design and plastic alloy insert, "DYFLON"® bearings have a long cycle life. Alignment and installation problems are minimized. Oil-free for life means lowest possible maintenance costs.

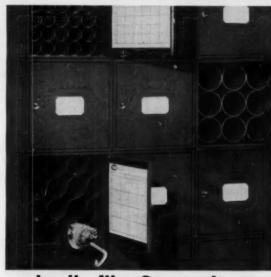
Available in a variety of plain or rod end types. Bore sizes to 3.000". Materials include stainless steel, plastic alloys and chrome alloy steels. Ultimate static loads to 500,000 lbs.

SOUTHWEST PRODUCTS CO.

1705 SO. MOUNTAIN AVE.
MONROVIA, CALIF. PHONE: MURRAY 1-9616

Circle 478 on Page 19



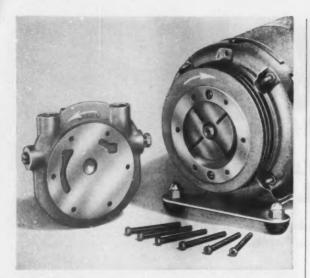


umbrella files? no.. please..

STACOR STAKTUBE® SYSTEMS FOR YOUR ROLLED DRAWINGS, PLANS, MAPS, BLUEPRINTS, ETC." Space-saving, easy-to-find, all steel encased 15% Square File comes complete with steel-rimmed tubes in 32 sizes, 4 ID, and 8 lengths. Files stack to any height . . . locks if desired. Write for literature, catalog: STACOR EQUIPMENT CO., 273 Emmet St., Newark 14, N. J.



STACOR STAKTUBE®



NEED AN OIL-FREE AIR SUPPLY?

Select from 3 types, 10 sizes

GAST OIL-LESS AIR PUMPS

You gain five advantages when you specify Gast Oil-less Air Compressors or Vacuum Pumps.

- Absolutely oil-free air delivery. No hot oil mist or odor can contaminate air flow.
- 2. No Imbrication required. This eliminates problems for both man-
- 3. Lubrication costs for both time and lubricants are eliminated.
- 4. You have greater freedom in locating the pump, as easy access for oiling isn't a factor.
- 5. Oil-less design adds a sales feature to your product!

How is this possible? Rotary design has carbon vanes that lubricate themselves. Ball bearings are grease-sealed for life and located outside the pumping chamber. Simple construction assures long, trouble-free dependability.

Ten sizes; capacities from .35 up to 24 c.f.m. running open. For medium duty to 10 p.s.i.g. pressure or 20" Hg vacuum. For use on instruments, medical and laboratory equipment, food packaging and paperhandling machines, Gast Oilless Air Pumps have much to offer.

A wide range of lubricated models also available.



Miniature models, .35 to 1 c.f.m.

Direct coupling drive, to 5.9 c.f.m.



Integral-motor types to 1.1 c.f.m.





V-belt drives, up to 24 c.f.m.

WRITE TODAY FOR OIL-LESS BULLETINS —
if possible, specify c.f.m. range that interests you.

GAST MANUFACTURING CORP.
P.O. BOX 117-P, BENTON HARBOR, MICHIGAN

for a long life of dependable, trouble-free service, *specify*

ATKOMATIC SOLENOID VALVES

Available in bronze and stainless steel for pressures from zero to 10,000 psi . . . temperatures from minus 350°F to plus 500°F . . . pipe sizes from ½° to 3° . . . for corrosive and non-corrosive gases, liquids and vapors.

More than 20 years of engineering experience and manufacturing skill go into the construction of each ATROMATIC Solenoid Valve

skill go into the construction of each ATKOMATIC Solenoid Valve.
Before shipment, valves are factory-tested on special flow lines under actual operating conditions to insure functional integrity and long, maintenance-free service. Experience and skill . . combined with exacting quality control . . . give you a lifetime of safe, reliable, low-cost operation.



545 WEST ABBOTT STREET INDIANAPOLIS 25, INDIANA write for Atkomatic Catalog no. 444



Circle 482 on Page 19

GEARMOTORS

- Speed up to 200 RPM
- Power up to 40 in. lb.
- Open or enclosed case
- Continuous or intermittent
- Machine cut gears
- Finish ground shafts
- Special features available
- Millions in use
- Prompt delivery
- Samples at onceAsk for our literature



Motoresearch also designs and produces high frequency motors, generators, rectifier type power supplies and other Special Electrical Equipment. We invite your inquiries



OPEN TYPE MOTOR

MILLIONS OF MOTORESEARCH GEARMOTORS NOW IN USE!

THE DOORESEARCH MANUFACTURING COMPANY, INC.

Designers and Manufacturers of special electrical equipment

MAYBE WE CAN DO IT BETTER AND FOR LESS

Hundreds of Companies have found us the Right Source of Metal-Fabricating

We have facilities, experience and engineering We have facilities, experience and engineering counsel which may meet your special requirements—exactly. Three large, well equipped plants at Aurora, Ill., York, Pa. and Los Angeles geared to economical production. Years of experience handling thousands of special items . . . products, parts, subassemblies, merchandising units, made to

dising units, made to

your specifications. Modern equipment includes coil steel slitting, leveling and edging, press work, all types of welding, electrostatic finishing.



Send for 16-Page Illustrated Booklet It tells All!

LYON METAL PRODUCTS, INC. General Offices, 981 Monroe Ave., Aurora, Illinois

Circle 484 on Page 19

HIGH-SPEED ADJUSTABLE Fit any size or shape opening



The patented adjustable action of Moeller's Snap-Tite® and Turn-Tite® cam and lever type action closures makes it possible to design a low-cost stopper in virtually any size or shape.

Made of cold-rolled or stainless steel and high-grade neoprene, or other specified materials, these new closures offer many opportunities to cut costs in product design, labor, time and assembly. For additional information, write . . . Industrial Division, Dept. 26

MOELLER MFG. CO., INC.

Greenville, Mississippi



flexible gear coupling you can buy!

Now you can transmit power in a wide range of speeds and capacities with the 14 ounce Nyflex® "Mite" nylon sleeve coupling. Use it in both the vertical and standard positions at speeds to 5000 rpm without lubrication. The "Mite" absorbs up to ±3° misalignment at these speeds yet the whole coupling is less than 3" in diameter.

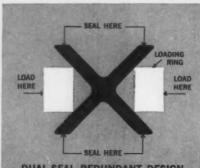
The "Mite" is available now in 3/8" rough bore and 8 finish bore sizes from .500" to 1.125" through over 150 industrial distributors. Use the inquiry card or write direct to Sier-Bath for the name of your nearest distributor and complete performance and specification information on the "Mite".



BAR -X- SEALS EVERYTHING AT TEMPERATURES FROM -400° F TO +1500° F!

ANY FLUID-GAS-FUELS-WATER-LIQUID METALS-CRYOGENIC FLUIDS-CORROSIVE FLUIDS ANY SYSTEM-HYDRAULIC-PNEUMATIC-VACUUM-CRYOGENIC-NUCLEAR





DUAL-SEAL REDUNDANT DESIGN
DYNAMIC & STATIC APPLICATIONS

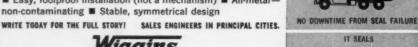


4" TO 3" STANDARD 3" TO 12" SPECIAL



NO CATASTROPHIC FAILURES INFINITE STORAGE LIFE UNPRECEDENTED SERVICE LIFE

Eliminates critical downtime ■ Very high and very low pressure ■ Easy, foolproof installation (not a mechanism) ■ All-metal non-contaminating Stable, symmetrical design





IT SEALS

E. B. WIGGINS OIL TOOL CO., INC., Dept. F1 3424 E. Olympic Blvd., Los Angeles 23, Calif. TWX 1403U, Phone AN 9-0181

Circle 487 on Page 19





New Multi-Position, Power-Saving FLUID CONTROL

Special 3800-SP, 102 G.P.M. with 2 Plungers and 4-Position Detent feature







Flance Mounting

HUSCO HYDRAULIC MULTI-PLUNGER VALVES

HUSCO Valves give you up to FOUR Control Positions — Raise, Lower, Float and Neutral, with or without Detent — for unusual advantages in versatility and performance. Available to control up to SIX cylinders, single or double acting, with Power-Saving Relief Valve. Capacities from 3 to 185 G.P.M. Over 120 standard models, with unlimited modifications to fit your specific need.

Get the whole story of HUSCO Features and advantages. Write for your copy of HUSCO'S "House of Ideas" — and engineering aid on your control needs.



HYDRAULIC UNIT SPECIALTIES CO.

PUMPS • VALVES • CYLINDERS
P. O. Box 257-M, Waukesha, Wisconsin

West Coast Representatives
EASTMAN PACIFIC CO., Los Angeles, Calif.
ROY BOBBS AIR-DRAULIC CO., Portland, Ore.

Circle 490 on Page 19



20 to 200 D.P.

Send your prints for quotations

- SPURS
- · HELICALS
- WORM AND
- . STRAIGHT BEVELS
- LEAD SCREWS
- RATCHETS
- . CLUSTER GEARS
- RACKS
- . INTERNALS
- . ODD SHAPES

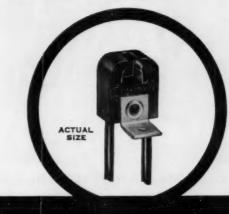


MINIATURE

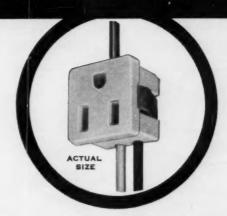
BI-PIN FLUORESCENT LAMPHOLDER

FOR T-5 LAMPS. 4, 6, 8, AND 13 WATTS

Can be quickly mounted in smallest possible space with single screw with various brackets when flush and surface mounting is desired; or as butt-on mounting without brackets. Rated at 75W. — 250V. Cat. No. 9240-2



CIRCLE F MINIATURES



MINIATURE "U" GROUND SNAP-IN OUTLET

For that limited space application. Mounts in less than one square inch. Rated at 15 Amp — 125V. wire leads only. Strong spring steel mounting clip for materials .025" to .095" thick. Cat. No. 1540

Take advantage of the new Circle F Miniature devices. Practical, attractive, low priced







CIRCLE F MFG. CO. TRENTON 4. NEW JERSEY



PRECISION PLASTIC BA

ACE is one of America's leading mass producers of seamless plastic balls for almost every commercial and industrial use. Most plastics

including nylon and teflon. Complete range of sizes, colors and tolerances. Small runs or large runs. Huge stocks for immediate delivery. Quick, low-cost service on specials. Write, wire or call for samples, price lists and handy new selection chart.

ACE PLASTIC COMPANY 91-18 VAN WYCK EXPWY - JAMAICA 35. N. Y.

Circle 493 on Page 19

IDEAS!

for heavy equipment __designers



Looking for new solutions to heavy-duty power problems? This new brochure has full information on heavy-duty transmissions with input torque capacities of 150 to 2500 ft-lb. Included is "idea material" describing:

- Standard transmissions customized to each application Wide variety of "engineered-to-order" transmissions
- Specifications (capacities, speeds, gear ratios) for heavy-duty applications
- Examples of single-speed, multiple-speed and right angle drive transmissions



Send coupon for your free copy . . . or see our Catalog in Sweet's Product Design File today!

Cotta Transmission Co., 2340 - 11th Street, Rockford, Illinois Please send my copy of "Cotta Heavy-Duty Transmissions" to Title

Address

To Protect Threads, Tubes, Valves, Components, etc. from Dirt and Mishandlin Available from Stock

ALUMINUM

Pipe Caps

Pipe Plugs

"D. O. C." Series Drive-on Caps

'D.I.P." Series

"C" Series AN & SAE Fittings.



"P" Series AN & SAE Fittings



"C-FT" Series to all Thread Speci-fications







"TY" Series Thick Wide Flange Ta-pered Plug & Cap



"EP" and "EE" Series Elec. Conn. Plugs & Caps HEEN



"IF" Series Plugs for Inverted Flare Fittings





"600" Series Sin-gle Thread Pipe Caps



"TC" Series Self-Sealing Caps—for AN & SAE Fittings





Series Flange Caps

Drive-in Plugs Special Closures Manufactured to Customers' Specifications, of Aluminum or Poly ethylene. Quotations on request, furnish description desired including thread size Manufacturers of Industrial Closures Since 1944

CLOVER INDUSTRIES, INC. 596 Young Street

Circle 495 on Page 19

WHAT'S YOUR ROBLE

PARTS? MATERIALS? COMPONENTS? FINISHES?

Perhaps one of our advertisers in this issue of MACHINE DESIGN has the solution to your dilemma. We'll be willing to bet that this issue contains information that is essential to answering your problem.

Fill out one of the yellow inquiry cards and send it to us. No letter or postage is necessary. We will forward your inquiry to the advertiser and he will reply directly to you.

Why not do it right now?

USE THE YELLOW CARD ON PAGE 19.

1



- AN Drilled Fillisters

- Head Cotter Pins Dowel Pins Hinges Machine Screws
- Screws Stud Bolts

Taper Pins Washers Wood Scre

STAR'S CATALOG OF

Right-off-the-Shelf ®

STAINLESS STEEL **FASTENERS**

8,000 stainless steel fastenings available for immediate delivery RIGHT OFF THE SHELF®

Write for your new Star catalog TODAY

STAR STAINLESS SCREW CO.

CORROSION RESISTANT

650 Union Blvd., Paterson, N.J. . CLifford 8-2300 Direct New York City phone: Wisconsin 7-6310 Direct Philadelphia phone: WAlnut 5-3660

Circle 496 on Page 19

Send For This **NEW FREE** Catalog On

DEUBLIN Rotating UNIONS

A completely new, 20

page illustrated catalog-manual showing all the models of Deublin Rotating Unions for water, steam, air, hydraulic, vacuum and coolant service for the machines you make or use, is just off the press to help you get trouble-free service and reduce your "down-time" and keep maintenance to a minimum. Shown are rotating joints for water and steam service; monoflow and duoflow unions; single and double passage rotating air unions; hi-pressure lo-torque unions; extra capacity air unions; rotating siphon pipe unions; in-the-shaft mounted unions; hydraulic rotating unions and hi-speed coolant unions. Complete with full engineering data, cut-away drawings, plus instructions for installing, lubricating and servicing Deublin unions.

Write for your free copy today.

DEUBLIN COMPANY

1923 STANLEY ST. . NORTHBROOK, ILL.



DIALCO for heavy duty industrial applications Mounts in 1" No. 104-3502-XP10-231 DISCS with legends, behind flat lenses, deliver specific messages. NO OIL, WATER, (Illust. approx. DUST or FUMES CAN 60% actual size) PENETRATE THE Built in BARRIERS

Complete oil-tightness on the panel surface is assured by the use of retained oil-proof gaskets-plus gasketed lens assemblies in which the lens is sealed to its metal holder.

Designed for Severe Service:

Heavy duty features include: One-piece solid brass bushing, solid brass lens holder, permanent-color glass lenses, high impact phenolic insulation, and rugged terminals.

Wide Range of Sizes: Series of units are available for mounting in clearance holes ranging from 11/16" up to 1-5/8" in

in 11/16"

No. 103-3502-1331

No. 125-410-1111



125-1308H-1191 (high brightness Neon)

diameter...with several lens styles in a choice of 7 colors... with binding screw, soldering, or quick connect terminals.

For Neon or Incandescent Lamps (with screw-base or bayonet-base): With Neon (including high-brightness types) DIALCO offers BUILT-IN RESISTORS (U.S. Pat. No. 2,421,321) for use on circuits of 105-125 V., and 210-250 V.; (simple external resistors are provided for all higher voltages).

Every assembly is available complete with lamp, SAMPLES ON REQUEST - AT ONCE - NO CHARGE Ask for Brochure L-200B.



54 STEWART AVE., BROOKLYN 37, N. Y. . HYacinth 7-7600

Circle 498 on Page 19



Leak Lock STOPS LEAKS where other compounds fail!

Here's a simple, economical solution to many troublesome leaking joint problems. Leak Lock holds LP, gasoline, oils, gases, petro-chemicals and refrigerants that eat through ordinary joint compounds. It's remarkably tough, highly adhesive, remains flexible indefinitely

. . . the joint compound that stretches rather than breaks. Years of use have established its advantages in stopping wasteful or hazardous leaks in the petroleum, chemical, atomic energy, electronic, refrigeration and other fields.

Listed by Underwriters' Laboratories for Gas and Oil Equipment List: Also for Propane and Butane.



For free sample, write on letterhead giving us the name of your local Industrial Distributor.

HIGHSIDE CHEMICALS INCORPORATED

11 Colfax Avenue • Clifton, N. J.

Circle 508 on Page 19



On this Jaeger concrete mixer, a FUNK-designed double right angle drive provides perfect alignment and positive chain

adjustment. Mounted vertically on the "unitized" front trunnion stand, FUNK's unit takes up only a fraction of the space normally used in such applications.

Just one example of how FUNK MODULAR POWER UNITS may be combined in an unlimited number of arrangements — without special engineering costs.

Let FUNK solve your power transmission problem.

FUNK MFG. CO.

Box 577-F, Coffeyville, Kon

NOW AVAILABLE

DESIGN

Data Sheets

The repeated requests for reprints of MACHINE DESIGN's Data Sheets has resulted in the collection of this useful information into handy, compact manuals. Each manual contains the complete set of Data Sheets appearing in MACHINE DESIGN during a single year. This excellent source of engineering information provides a constant reference for engineers seeking valuable short cuts to design problems. Each manual sells for only \$2.00 per copy yet pays big dividends in time saved.

The 1960 volume contains a cumulative index of all published Data Sheets in the preceeding volumes.

These worthwhile Data Sheet manuals are the only ones of their kind available. Order a set today for your department or personal library. Use the convenient form below for prompt service.

MACHINE DESIGN
Penton Bldg.,
Cleveland 13, Ohio

(Remittance or Company Purchase Order must be enclosed with order)

Please send me:

COMPANY

ADDRESS

CITY ZONE STATE

(Add 3% to orders in Ohio to cover State Sales Tax)





ROTARY JOINTS



BARCO is HEADQUARTERS for Rotary Joints! Types . . . Sizes . . . Styles for every purpose:

Type C—Top performer in industry for dryers, dry cans, rolls, and drums. Threaded ends, ½" to 3". Syphon or single flow. Steam, water, oil, air, gas, or chemicals. Also Type CR for rotating syphon.

Type CF-Flanged end connection for easy installation. 1½", 2", 2½", 3". 200-225 psi.

Series 300—Large size, up to $21/2'' \times 21/2''$, 300 psi joints for circulating liquids. To 600° F.

Type CC-New heavy duty rotary joint for handling shock loads on calender rolls.

Types D - E—High speed, ball bearing ¼" rotary joints for hydraulic fluids, coolants, and compressed air on spindles, drills, and clutches

COrite Send for latest catalogs. BARCO MANUFACTURING CO.

Soc K Hough Street
Barrington, Illinois Barrington, Illinois

Circle 510 on Page 19



Send your toughest threaded Possener fastener problems to Nylok

We will analyze your problem and show you how inexpensive it can be to get the best and most economical insurance against equipment malfunction caused by loosening of threaded joints. This insurance is evidenced by the billions of Nylok-engineered fasteners now serving in thousands of applications. MIL-F-18240A (ASG) states that Nylok fasteners are "intended for use in tapped holes in place of lock-wired bolts and

The key to the Nylok principle is this tough, elastic pellet that offers complete design versatility.

Only Nylok has the patented principle which can be applied to any threaded joint ... male or female, any shape, any size, any material . . . to make it:

LOCK: against conditions of vibration and shock

SEAL: against fluid leakage along the threads

ADJUST: prevailing torque keeps it exactly where you wrench it . . . without being seated

Call Nylok at COlfax 1-9400, in Paramus, New Jersey, or send your problems to us at Dept. N2-19.

FREE DESIGN DATA

Circle the indicated number on the Reader Service Card. and we'll send you a copy of our 24 page catalog, giving complete, basic product and application data.



THE NYLOK® CORPORATION

611 Industrial Avenue, Paramus, N. J.

8046 Central Park Ave., Skokle Illinois. Western: 18222 Maple Ave., Gardena, Calif.



what's the big



On the left, a conventional metallic fastener. On the right, a Nylogrip nylon fastener. The big difference: Nylogrip is an excellent insulator, eliminates need for collars and washers. Nylogrip is corrosion and chemical resistant. Nylogrip is selflocking, eliminates need for locking devices. Nylogrip is more than 50% lighter, yet has tensile strengths up to 15,700 p.s.i. Nylogrip is available in a full range of colors. Nylogrip is highly heat resistant—form stable up to 450° F, withstands up to 300° F continuous heat with special nylons. Best of all: Nylogrip has largest available stock of non-metallic fasteners. Economical small lot prices, fast delivery. Specials engineered to your requirements. WRITE FOR DETAILS.

NYLOGRIP NYLON FASTENERS -Stocked in most head styles; diameters: #2 through ½"; lengths ½" through 2"; hex nuts, flat washers, set screws—threaded rod—lock nuts—nylon balls—PVC fasteners—Nylogrip Dubo Lockwashers.



Circle 513 on Page 19

IN THE LEVEL



that's the only way to operate machines!

A fine, positive adjustment with a hand wrench, and 60,000 lbs. of expensive machinery is protected against the hazards of misalignment. Empco Leveling Jacks set your machines level . . . keep them level. Used with Vi-Sorb Mounting Pads, they also damp out excessive noises, reduce transmitted vibrations by up to 85%! Easy to install. 6 styles, 25 models. Vi-Sorb Pads cut to fit.

WRITE FOR BULLETIN 100





ENTERPRISE MACHINE PARTS CORP

2723 Jerome Ave. Detroit 12, Mich.

Circle 514 on Page 19

BASIC ENGINEERING HELP FROM



FOR VEHICLE DESIGNERS ONLY

MOBILITY OF CROSS-COUNTRY VEHICLES

A series of articles presenting up-to-date design data and mathematical methods for analyzing off-the-road locomotion of vehicles.

Matching vehicle design to

- soil characteristics
- thrust
- flotation
- motion resistance
- · track and wheel requirements
- · optimum loads

are the relationships covered in the booklet.

\$1.00 a copy

FRICTION-CLUTCH TRANSMISSIONS

A basic guide for the selection and application of friction clutches to reliably join power transmission elements. Parameters for the balance of complete transmission systems, in the design stage, are presented in this four-part series.

\$1.00 a copy

MACHINE DESIGN

Penton Building Cleveland 13, Ohio

Please send me_ _copies of

"Mobility of Cross-Country Vehicles"

Please send me . copies of

"Friction-Clutch Transmissions"

Remittance or Company Purchase Order must be enclosed with order.

NAME

COMPANY

ADDRESS

CITY

ZONE STATE

(Add 3% to orders for delivery in Ohio to cover State Sales Tax)



bronze, knifeedged wiper rings, mounted in a synthetic rubber cushion ring, throw all foreign matter clear of the rod.



Seal-Guard's unique metallic rod wipers are easy to install and self-adjusting. Their

floating cushion absorbs side thrust, prevents scarring of the rod. Practically friction-less, they resist oil and heat for

long, trouble-free service.

Standard sizes for 1/4" to 6" diameter rods. May be special-ordered up to 241/4" in diameter.



HYDRAULIC ACCESSORIES CO.

24301 Hoover Road, Warren Mich.

Circle 515 on Page 19

NEW-TYPE FHP PULLEYS AND SPEED REDUCERS SAVE YOU 33% PER UNIT

You can now cut costs on fractional horsepower equipment of all kinds with these unique, metal and nylon-fiberglass products. Rampe Variable Pitch Pulleys and Speed Reducers wear longer, run quieter, and cost less. Savings are 33% or more per unit in lower initial cost and added chemical resistance, impact strength, self-lubrication for hard-to-reach applications.



Speed Reducers

Complete line includes gear ratios up to 1500 to 1. Machined steel worm gear drive shaft, choice of aluminum or nylon output gear, in fiberglass reinforced case. 1/4" solid or hollow shaft. Model SW-1, for applications up to 1/4 hp.



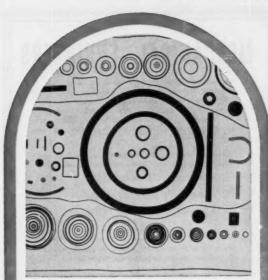
Molded nylon-fiberglass with metal-reinforced inside flanges to resist belt wear. Metal bonded to nylon under 10 tons/sq. in. pressure. Standard 2.45 to 1 infinitely variable speed range. Three sizes: for 1/4", 3/8", and 1/4" V-belt drives up to 1/2 hp rating.

Send for latest catalog sheets containing complete details on Rampe shp products. See how you can save with better performance at lower cost.



AMPE MFG. CO.

14915 WOODWORTH AVE., CLEVELAND 10, OHIO



Mr. Design Engineer:

we pull the rug out from under rugged problems involving **Precision Molded Parts**

Design engineers' problems involving custom-designed, precision molded parts for hydraulic and pneumatic systems . . . especially the tough ones . . . are welcomed at AERO GASKET. Molded parts of rubber compounds such as Viton, silicones, buna N, and Neoprene in an infinite variety of shapes and sizes can be supplied for components that must be supplied for components that must be supplied. of shapes and sizes can be supplied for components that must operate at temperatures as low as —65°F or up to 600°F. High and low temperature plastics such as Teflon and Kel F are also used by AERO GASKET in developing molded parts that conform to the most demanding tolerances. All compounds are controlled by ASTM test methods, SEND SPECS AND BLUEPRINTS FOR PROMPT QUOTATIONS.

MAIL COUPON FOR DATA SHEETS

THE AERO GASKI 39 Hanover Street,				
☐ Please send r Gasket Precision	me the Data on Molded Pa	Sheets	describing	Aero
I am also intereste Precision Meta Diaphragms ar	l Parts nd Diaphragm	Assemb	als and Gas lies	kets
name				_
co. address				
city				



AERO Gasket

CORPORATION Meriden, Connecticut

DIAPHRAGMS . ACTUATORS . ACCUMULATORS METALLIC & NONMETALLIC GASKETS CLAMPS OF ALL TYPES AND DESCRIPTIONS MOLDED RUBBER PARTS . METAL STAMPINGS . METAL-TO-RUBBER BONDING

Circle 517 on Page 19

MECHANICAL ENGINEERS

Planned expansion at AMF Atomics, a division of American Machine & Foundry Company, has created many career opportunities for Mechanical Engineers. Applications of atomic energy for space propulsion have opened up a vast new field of diversified assignments requiring initiative and imagination at professional levels.

Immediate positions are available to qualified applicants having experience in the development of:

- . AUTOMATIC MACHINERY
- . GROUND SUPPORT EQUIPMENT
- . SPECIAL PURPOSE VEHICLES

Nuclear experience is not essential. Our staff can provide you with nuclear know-how and training. Engineers with proven capability in the development of complex mechanical and electromechanical equipment will find their experience directly applicable to problems in the atomic energy field. Our company is recognized as a world leader in the fields of atomic energy, recreational products and automatic machinery.

Submit replies, outlining education, experience and salary requirements, to:

MR. J. PRINDEVILLE



AMF ATOMICS

140 Greenwich Ave.—Greenwich, Conn.

A Division of American Machine & Foundry Company

An Equal Opportunity Employer

Circle 518 on Page 19

ENGINEERS AVAILABLE OR WANTED

WANTED: Two graduate mechanical engineers (BSME) for design and development work on ball valves, diaphragm valves, and chemical metering pumps. A minimum of five years' product design experience is required. Background in pumps, valves, hydraulics, or flow problems is highly desirable. Must have initiative and creative ability, with potential for developing into a design group leader. This is a real opportunity with a company whose sales have tripled during the past ten years, and which is aggressively engaged in new product development for further expansion and diversification. Ideal working conditions in a modern air-conditioned plant located in the scenic Fox River Valley just 30 minutes from Chicago. Send resume to Mr. Lew Carlino, Hills-McCanna Company, 400 Maple Avenue, Carpentersville, Illinois.

WANTED: Stress Engineer/Machine Designer, Machine Frame Structures. Great Lakes area 38-year old leader in earthmoving machinery field offers unusual challenge to Machine Designer to set up an Experimental Stress Activity. He will have strong interest and proven ability in experimental stress analysis and have had actual experimence in the attachment and use of stress instrumentation. including interpretation of test data. The man will probably be a Graduate Mechanical Engineer with three to ten years' experience in the personal design of machine frame structures, gears, hydraulic circuitry and power transmission equipment. Permanent position. Excellent remuneration, liberal Profit Sharing Plan, other benefits. Sell yourself with full particulars in strict confidence. Box 101, MACHINE DESIGN, 1213 West Third Street, Cleveland 13, Ohio.

ENGINEERS AVAILABLE OR WANTED

Employment Agency: A challenging opportunity for a senior development engineer to take charge of a progressive research and development program with a Midwestern firm. Starting salary in five figures. Personnel Engineering. 1102 Broadway, Rockford, Illinois; 3300 Peterson Avenue, Chicago, Illinois.

WANTED: Exceptional opportunity for engineer (B.S.M.E. minimum) with several years machine design board experience interested in design and development of complex production machinery. Will handle special projects for central design section of leading national multiplant organization. Will not do board work. To start three month in-plant training program. Located near Milwaukee, Wisconsin. Our employees know of this ad. Please send complete resume and starting salary to Box 995, MACHINE DESIGN. 1213 West Third Street. Cleveland 13, Ohio.

à

1

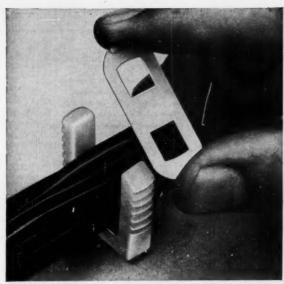
WANTED: Machine Design Engineer. Machine designer with five or more years of experience required. Assignment will include work on small and medium sized automatic, high speed equipment for use in the packaging field. Experience in the design of filling machines or dry packaging machines very beneficial. Excellent opportunity with large central Ohio manufacturer. All replies held in confidence. Forward resume, including salary requirements to Box 102. MACHINE DESIGN. 1213 West Third Street. Cleveland 13. Ohio.

WANTED: Supervisory Machine Design Engineer; minimum of ten years machine design and responsible supervisory experience required. Paper converting or paper box background desirable. Company established approximately sixty years ago, has had unusual growth; is located in Southeast with branches in all sections of the U. S. Company is reliable, progressive and has excellent personnel relations. Salary open depending on qualifications. Reply to Box 996, MACHINE DESIGN, 1213 West Third Street, Cleveland 13. Ohio.

AVAILABLE: Automation Expert as Consultant. M.S.M.E.. broad. diversified experience in automation systems. expert in the design. development and evaluation of automation machines. high speed mechanisms, and manufacturing processes. Many years of association with leading corporations in industry. Address Box 997. MACHINE DESIGN. 1213 West Third Street, Cleveland 13. Ohio.

WANTED: Exceptional opportunity for a machine designer (BSME minimum) with board experience. He should be a natural mechanic and interested in the design and development of complex mechanisms and automatic production machinery with associated electrical controls. Located in Central New York. If a man has initiative, possesses sound judgment in technical field and has a desire to be creative, he should send his complete resume and starting salary to Box 999, MACHINE DESIGN. 1213 West Third Street. Cleveland 13, Ohio.

WANTED: Senior Machine Designer (Machine Frame Structures) Great Lakes area. 38-year old leader in earthmoving machinery field offers unusual challenge and opportunity to Senior Machine Designer with sound grounding in the fundamentals of Mechanical Engineering, plus outstanding initiative and ability for getting the job done. Successful candidate will report directly to the Chief Engineer and assume full responsibility from concept through layout, stressing to finished product. Duties will include necessary supervision, writing reports, contact with other departments, vendors and field trips. The man will probably be a graduate Mechanical Engineer with 5 to 15 years' experience in the personal design of gears, machine frame structures, hydraulic circuitry and power transmission equipment. Permanent position. Excelent remuneration. Liberal profit sharing plan and incentive bonus. Sell yourself with full particulars in strict confidence. Box 100. MACHINE DESIGN. 1213 West Third Street, Cleveland 13, Ohio.



CLAMP WIRE BUNDLES IN SECONDS!

Just place wire bundle inside "U," push keeper down snugly, and this light-weight clamp is securely locked to withstand loadings greater than 50 C's! A Cab-L-Tite* clamp securing 58,000 mils weighs only 0.016 oz.; 8,570,000 mils, 0.832 oz. Proved in aircraft and missiles, Cab-L-Tite* is made of tough DuPont zytel, which meets MIL-P-17091. Removable in seconds for rerouting wires. Write for free literature.

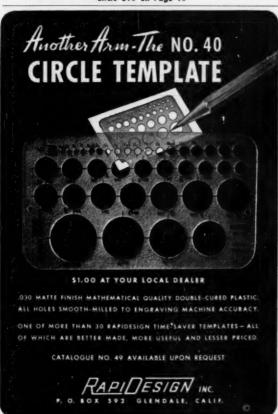
Manufacturer of Bund-L-Tite straps.

DAKOTA ENGINEERING, INC.

4315 Sepulveda Blvd., Culver City, California

*Trade Mark

Circle 519 on Page 19



Outstanding openings for

Tool Engineers

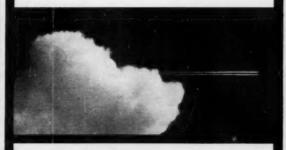
Boeing, the world leader in the field of jet transportation, is at work on advanced jet transportation systems of the future. These long-range programs offer tool engineers outstanding opportunities to move ahead in their special fields.

Assignments involve creative layout and design of gauges, jigs, handling equipment, spar mill and machine fixtures, and special tools for production of military and commercial jet aircraft. Assignments may also include investigation, analysis, follow-up and development of corrective action necessary to resolve problems related to the fabrication, tryout, rework and usage of tools. Requirements: a B.S. degree in engineering, preferably mechanical or civil. Experience in aircraft tool engineering desirable.

Salaries are competitively commensurate with experience. Boeing pays liberal travel and moving allowances.

At Boeing you'll enjoy the advantages of living in the uncongested Pacific Northwest, famous for mild year-round climate, unexcelled recreational facilities, modern housing and fine schools.

Send your resume, today, to Mr. Ivan G. Phillips, The Boeing Company, P. O. Box 707 - 87U, Renton, Washington. The Boeing Company is an equal opportunity employer.



BOEING

.. environment for dynamic career growth

Advertising Index

Abbott Ball Co., The 322	Bristol Motors, Division of Vocaline Company	Elliott Co300, 3
Ace Plastic Co 388	of America	Enjay Chemical Co., A Division of Humble Oil
Acme Chain Corporation	Buffalo Forge Co., Buffalo Pumps Division 381	& Refining Co 3
Adhesives Department, Raybestos-Manhattan,	Buffalo Hydraulics Division, Houdaille	Enterprise Machine Parts Corporation 3
Inc 319	Industries, Inc	Equipto Electronics Corporation 2
Aero Gasket Corporation, The 393	Bundy Tubing Co	Erio Pacific, Division of Erio Resistor
Airborne Accessories Corporation 82	Bunting Brass and Bronze Co., The 330	Corporation
Air Marine Motors, Inc 324	Busada Manufacturing Corporation 377	Erie Resistor Corporation, Erie Pacific
Alco Products, Inc 225		Division
Allengir Corporation		Exact Weight Scale Co., The 25
Allen-Bradley Co	Carpenter Steed Co., The	
Allied Chemical, Plastics Division	Chain Belt Co 9	
117, 118, 119, 120	Champion Rivet Co., The	Faber-Castell, A. W., Pencil Co.,
Allis Chalmers, Industrial Equipment Division 66	Chicago-Allis Mfg. Corporation 223	Falk Corporation, The126, 13
Allis, Louis, Co., The	Chicago Rawhide Manufacturing Co.,	Farrel-Birmingham Co., Inc
American Bosch Arma Corporation, Commercial	Sirvene DivisionBack Cover	
Sales Division	Chrysler Corporation, Amplex Division 294	Fellows Gear Shaper Co., The
American Brake Shoe Co., Denison Engineering	Cincinnati Gear Co., The	Fenwal, Inc
Division	Circle F Mfg. Co	Flick-Reedy Corporation, Miller Fluid Power Division
American Chain & Cable Co., Inc., Automotive	Clark Controller Co., The	
and Aircraft Division 90	Clearprint Paper Co	Flick-Reedy Corporation, Tru-Seal Division 37
American Hardware Corporation, The, Corbin	Clover Industries, Inc	Force, Wm. A., & Co., Inc
Cabinet Lock Division 378	Colorado Oil and Gas Corporation, Marsh	Franklin Electric Co., Inc
American Insulator	Instrument Co. Division 220	Funk Mfg. Co
American Machine & Foundry Co., AMF	Columbia-Geneva Steel Division, United States	
Atomics Division 394	Steel Corporation	
American Machine & Foundry Co., Potter &	Continental Can Company, Paperboard and	Gamewell Co., The, Eagle Signal Co. Division 34
Brumfield Division	Kraft Paper Division	Gardner-Denver Co 27
American Machine and Metals, Inc., Hunter	Continental-Diamond Fibre Corporation 98	Garlock, Inc.
Spring Co. Division	Controls Company of America, Control Switch	Gast Manufacturing Corporation 38
American Machine and Metals, Inc., The Lamb Electric Co Division	Division	Gates Rubber Co., The
	Control Switch Division, Controls Company of	General Aniline & Film Corporation, Ozalid
American Nickeloid Co	America	Division
American Sealants Co., The	Copperweld Steel Co., Aristoloy Steel Division 2	General Electric Co
American Society for Metals	Copperweld Steel Co., Ohio Seamless Tube	General Electric Co., Chemical Materials
American Steel & Wire, Division of United States Steel Corporation	Division122, 123	Department
American Stock Gear Division, Perfection Gear	Corbin Cabinet Lock Division, The American	General Electric Co., Metallurgical Products
Co 340	Hardware Corporation 378	Department
AMF Atomics, A Division of American Machine	Corning Glass Works 359	General Electric Co., Silicone Products
& Foundry Co	Cotta Transmission Co	Department
AMP, Inc21, 279	Cramer Division, Giannini Controls Corporation 11	General Fittings Co 37
Amplex Division, Chrysler Corporation 294	Crane Packing Co	General Motors Corporation, New Departure
Anaconda American Brass Co 5	Crawford Fitting Co	Division 36
A. P. M. Corporation	Cutler-Hammer, Inc	Georator Corporation
Aristoloy Steel Division, Copperweld Steel Co. 2		Giannini Controls Corporation, Cramer Division 1
Armstrong Cork Co		Gibson Electric Sales Corporation 28
	Dakota Engineering, Inc	Gits Bros. Mfg. Co
Arrow Hart & Hegeman Electric Co., The64, 65	Danielson Manufacturing Co., The 230	Globe Industries, Inc 40
Atkomatic Valve Co., Inc 384	Denison Engineering Division, American Brake	Goodrich, B. F., Aviation Products, A Division
Aurora Pump Division, The New York Air Brake	Shoe Co	of The B. F. Goodrich Co 21
Co., The 262	Detroit Power Screwdriver Co 277	Goodrich, B. F., Co., The, B. F. Goodrich
Automatic Electric 96		Aviation Products Division
Automatic Timing & Controls, Inc	Deublin Co	Goodyear Tire & Rubber Co., The, Industrial
Automotive and Aircraft Division, American	and an annual contract of the	Products Division84, 8
Chain & Cable Co., Inc 90	Diamond Chain Co., Inc	Gould, J. D., Co
Automative Gear Division, Eaton Manufacturing Co	Dimco-Gray Co	Gray Tool Co., Grayloc Sales Division 29
Auto-Ponents, Inc	Dixon Corporation 346	Great Lakes Steel, Division of National Steel
Avišun Corporation	Dodge Manufacturing Corporation 290	Corporation
241	Doehler-Jarvis, Division of National Lead Co. 107	Gries Reproducer Corporation 37
	Dow Corning Corporation269, 270	Grip-Nut Co 37
Barber-Colman Co	Driv-Lok Sales Corporation 379	
Barco Manufacturing Co	Duff-Norton Co 317	
Barksdale Valves, Pressure Switch Division 376	Durez Plastics Division, Hooker Chemical	Hamilton Manufacturing Co
Beaver Gear Works, Inc	Corporation 323	Hendy & Harman
Bendix-Westinghouse Automotive Air Broke Co. 121	Dynapar Corporation	Hansen Manufacturing Co., Inc 321
Bethiehem Steel Co		Harrington & King Perforating Co., Inc., The 43
Bijur Lubricating Corporation 46	Reals Stead Co. Blatter of the Committee	Hart Manufacturing Co., The
Bliss & Laughlin	Eagle Signal Co., Division of The Gamewell	
Boehme, H. O., Inc	Co	Haves Industries, Inc. Taunton Division 28
Booing Co., The	Eastern Industries, Inc	Haynes Stellite Co., Division of Union Carbide Corporation
lound Brook Bearing Corporation of America	Eaton Manufacturing Co., Automotive Gear Division	Heinemann Electric Co 28
Inside Front Cover	Elastic Step Nut Corporation of America 48	Heinze Electric Co
	and the section of butteries	21

	-
Hewitt-Robins272, 273	
Highside Chemicals, Inc	
Hilliard Corporation, The	
Hitachi, Ltd	
Hoke, Inc	
Holan Corporation, Universal Hydraulics Division	
Holtzer-Cabot Motor Division, National Pneumatic Co., Inc	
Hooker Chemical Corporation, Durez Plastics	
Division 323	i
Hoover Ball and Bearing Co 97	
Horsburgh & Scott Co., The 296	
Horton Manufacturing Co., Inc 380	ľ
Houdaille Industries, Inc., Buffalo Hydraulics Division	
Houghton, E. F., & Co 304	
Humble Oil & Refining Co., Enjay Chemical	
Co. Division 341	
Hunter Spring Co., A Division of American	
Machine and Metals, Inc 280	
Hunt Valve Co., Division of IBEC 125	
Hyde, A. L., Co	
Hydraulic Unit Specialties Co	
Hydro-LineInside Back Cover	
.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
IBEC, Hunt Valve Co. Division 125	
Ideal Corporation	
Imperial-Eastman Corporation224, 225	
Industrial Retaining Ring Co	
Industrial Timer Corporation	
Industrial Timer Corporation, Line Electric Co.	
Division 38	į
International Business Machines Corporation	
205, 399	
205, 399 International Nickel Co., Inc., The 67 Jack & Heintz, A Division of The Siegler	
205, 399 International Nickel Co., Inc., The	
205, 399 International Nickel Co., Inc., The	
205, 399 International Nickel Co., Inc., The	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
205, 399	
Jack & Heintz, A Division of The Siegler Corporation	
Jack & Heintz, A Division of The Siegler Corporation	
International Nickel Co., Inc., The	
International Nickel Co., Inc., The	
International Nickel Co., Inc., The	
Jack & Heintz, A Division of The Siegler Corporation	
205, 399	
Jack & Heintz, A Division of The Siegler Corporation	

McCord Corporation, Lubricator Division	246
to dill the desired Co. Inc. Booring	
Division	132
Engineering Co. Division	
Madison-Kipp Corporation	284
Maileable Castings Council60,	
Manhattan Rubber Division, Raybestos-	21.0
Manhattan, Inc	
Marsh Instrument Co., Division of Colorado	
Oil and Gas Corporation	220
Maxson Electronics Corporation, Unimax Switch Division	382
Mayline Co., Inc	381
M-D Blowers, Inc	
Meshanite Metal Corporation	
Metallized Carbon Co	
Metallurgical Products Department, General	
Electric Co.	102
Miller Fluid Power, Division of Flick-Reedy Corporation	115
Miniature Precision Bearings, Inc 314,	315
Moeller Mfg. Co., Inc	385
Monsanto Chemical Co., Organic Chemicals Division	73
Moore, George W., Inc	
Moore, Samuel, & Co	
Morganite, Inc.	
Motoresearch Manufacturing Co., Inc., The Mt. Vernon Die Casting Corporation	
Mueller Brass Co42,	
National Acme Co., The	275
National Lead Co., Doehler-Jarvis Division	
National Machine Products Co	
National Pneumatic Co., Inc., Holtzer-Cabot	320
National Screw & Mfg. Co., The	
National Steel Corporation, Great Lakes Steel	
Division	07
Corporation	368
New Hampshire Ball Bearings, Inc216,	
New York Air Brake Co., The, Aurora Pump	
Division	
Norgren, C. A., Co	
Nylogrip Products	392
region Corporation, Ind	371
Ohio Seamless Tube, Division of Copperweld Steel Co	123
Ohmite Manufacturing Co	
Oilgear Co., The	7
Olin Aluminum	29
Ozalid, Division of General Aniline & Film Corporation	325
Packings Division, Raybestos-Manhattan, Inc. Penn Engineering & Manufacturing Corporation	
Perfecting Service Co	
Perfection Gear Co., American Stock Gear	
Division	340 56
Pittsburgh Steel Co	
Polymer Corporation of Pennsylvania, The	

DESIGN

Penton Building, Cleveland 13, Ohio

BUSINESS STAFF

ROBERT L. HARTFORD

RICHARD A. TEMPLETON Director, Research & Promotion

MARY L. CALLAHAN Advertising Service Mand

BARBARA O'LEARY

AMY LOMBARDO

ROBERT E. LESSING Production Manager

District Offices

Rochester 18, N. Y.175 Greenvale Drive GEORGE M. ISBELL, Hillside 5-1771

Dresher (Philadelphia), Pa.1335 Harris Rd. CHANDLER C. HENLEY, Mitchell 6-2585

Detroit 3515800 West McNichols Rd. H. F. SMURTHWAITE, Broadway 3-8150

Chicago 11

Los Angeles 365943 West Colgate Ave. F. J. FULLER, Webster 1-6865

Los Angeles 5730 South Western Ave. The Robert W. Walker Co., Dunkirk 7-4388

Birmingham 9249 La Prado Place FRED J. ALLEN, Tremont 1-8598

Clearwater, Fla. 1954 Jeffords Dr. H. G. ROWLAND, Dial 441-4121

Dallas 35525 Exchange Bank Bidg. JAMES H. CASH, Fleetwood 1-4523

London, S.W. 1 2 Caxton St., Westminster

Published by

1116	LEIALOIA	LOBEISHING	COMPAUL
GEORGE	O. HAYS		Chairman
RUSSEL	L C. JAEN	KE	President
FRANK	G. STEINEB	ACH Vice Pres	. & Secretary
FRANK	O. RICE .		ice President
JOSEPH	P. LIPKA	Vice Pres.	& Treasurer
DAVID	C. KIEFER	Vice Pre	sMarketing
IRWIN	H. SUCH	Vice P	resEditorial
ROBERT	L. HARTFO	RD	Vice President

Also Publisher of STEEL, FOUNDRY, NEW EQUIPMENT DIGEST, AUTOMATION

AUTOMATION

MACHINE DESIGN is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and machanical equipment, in U. S. and Canadian companies employing 20 or more people. Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. government installations, performing design engineering of products are also eligible.

Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, \$10. Single copies \$1.00. Other countries: One year, \$25. Published every other Thursday by The Penton Publishing Co., Penton Bidg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.





backtalk-

-Folks, Meet Nokes



Jim Nokes is the newest assistant editor on Machine Design's staff. He came from Rochester, N. Y., where he was a senior manufacturing engineer for General Dynamics Electronics Co. Earlier milestones in his career include positions as casting and forging design engineer for Martin Orlando, acting supervisor of producibility engineering for Temco Aircraft Corp., and design cost analyst for Chance Vought. Jim is a mechanical engineer, educated at the University of Maryland, and he holds a professional engineer's license.

During World War II he wore sergeant's stripes and was an aerial gunner; in 1951-52 he served bravely as a lieutenant at Hill AFB, Utah, in the Air Materiel Command.

Jim's avocational interests run the gamut from b to w (bowling to woodworking). Since he arrived in Cleveland near the end of the summer fun season, he is making plans for next year's tennis, swimming, sailing, and fishing. He will pass the winter matching strikes with other Penton bowlers, reading, going to concerts, and building bookcases and a hi-fi set in his apartment.

-Save Our Squirrels

This is a happy-ending animal story. Managing Editor Bob Stedfeld recently learned from the Polymer Corp. that a sizable market for one of its products has been created by squirrels. It seems that the bushy-tails are wont to sit on transformers—which is okay unless one happens to touch the transformer and a high-tension wire simultaneously. This, of course, shorts out the transformer and does in the poor squirrel. An application of Polymer's thick plastic coating, however, provides electrical insulation, making a transformer squirrelproof as well as weatherproof.

-Bowling Green, Yellow, Pink, etc.

With the advent of the 1961 kegling season comes news from Celanese Corp. of America of compression-molded polyester bowling balls. Most balls are made of hard rubber for durability, but the new ones are expected to hold up just as well. And they'll be prettier. Prudently aimed at the feminine market, the new balls will come in all colors, translucent, and/or with things (like team emblems, spangles, or artificial flowers) embedded in them.

On the whole, bowling-ball beautification seems a fine idea, but will it bring problems? Like if two lady bowlers show up with the same flower arrangement? Also, will a girl have to have outfits to match her ball, or vice versa? Will styles change each season, making it less than chic to use last year's ball? Will different models be proper for daytime and after five?

All this remains to be seen. We predict only one thing: A lady will be less embarrassed about rolling an 87 game if she did it with a sphere full of daisies than if she'd used a dull black cannonball.

-Correspondents Anonymous

A group in Niagara Falls known as "Eng. Design Office" sent us a postal card which reads:

We would appreciate it if you would answer the following questions in Machine Design:

1. Is there a National Society of Design Engineers?

 What kind of an organization is Engineers & Scientists of America? Thank you.

Answers:

1. No, there is no national society of design engineers. The closest thing to such an organization is the Machine Design Division of the American Society of Mechanical Engineers. This group meets every year during ASME's Summer and Winter Meetings and also presents the conference program at the Design Engineering Show each spring. Detailed information on the Machine Design Division's activities can be obtained by writing to ASME, 345 E. 47th St., New York 17. N. Y.

2. ESA (no longer in existence) was a federation of engineering unions.

You're welcome, whoever you are.

Advertising Index

Post, Frederick, Co	Torq Engineered Products, Inc
Machine & Foundry Co	Torrington Co., The
Precision Rubber Products Corporation 283	Tubular Rivet & Stud Co
Precision Tube Co., Inc	Tuthill Pump Co
Protective Closures Co., Inc., Caplugs Division 365	Twin Disc Clutch Co 207
Racine Hydraulics & Machinery, Inc.,	Uniform Tubes, Inc
Hydraulics Division	Unimax Switch Division, Maxson Electronics
Rae Motor Corporation	Corporation
Rompe Mfg. Co	Union Carbide Corporation, Haynes Stellite Co.
RapiDesign, Inc. 395 Raybestos-Manhattan, Inc. 318, 319	Division
Recordak Corporation	Union Carbide Corporation, Silicones Division 101
Reliance Electric and Engineering Co 104, 105	United States Graphite Co., The, Division of
Robbins & Myers, Inc	The Wickes Corporation
Rohm & Haas Co	United States Rubber, Mechanical Goods
Roper Hydraulics, Inc 282	Division112, 113
Ross Operating Valve Co	United States Steel Corporation, Subsidiaries
Russell, Burdsall & Ward Belt and Nut Co 59	49, 50, 51, 52, 53, 74, 75 United States Steel Export Co74, 75
Ruthman Machinery Co., The 274	Universal Hydraulics, Division of Holan
	Corporation
	U. S. Axie Co., Inc., The
Sandusky Faundry & Machine Co	
Schroder's, A., Son, Division of Scovill	
Manufacturing Co., Inc	Vickers, Inc., Division of Sperry Rand
Scovill Manufacturing Co., Inc., A. Schrader's Son Division	Corporation, Aero Hydraulics Division 91
Screw and Bolt Corporation of America 201	Victor Mfg. & Gasket Co
Scully-Jones and Co., Special Products Division 349	Viking Pump Co
Sealmaster Bearing Division, Stephens-Adamson	Vocaline Company of America, Bristol Motors
Mfg. Co 266	Division
Set Screw & Mfg. Co	Vulcan Electric Co
Shell Oil Co	
Shenango Furnace Co., The, Centrifugal Casting Division	
Siegler Corporation, The, Jack & Heintz	Wagner Electric Corporation
Division 343	Waldes Kohlnoor, Inc. 215 Ward Leonard Electric Co. 308
Sier-Bath Gear and Pump Co., Inc., Flexible	Warner Electric Brake & Clutch Co
Coupling Division	Waterman Hydraulics Corporation 217
Simmons Fasteners	Watlow Electric Manufacturing Co 299
South Chester Corporation, South Corporation 92	Weatherhead Co., The 210, 211
Southwest Products Co	Webster Electric, Oil Hydraulics Division 267
Spaulding Fibre Co., Inc	Western Gear Corporation, Industrial Products
Sperry Rand Corporation, Vickers, Inc.	Division
Division, Aero Hydraulics Division 91	Westinghouse Electric Corporation228, 229 Westinghouse Electric Corporation. General
S-P Manufacturing Corporation, The, A Bassett	Purpose Control Dept
Co	Westinghouse Electric Corporation, Standard
Stacor Equipment Co	Control Division94, 95
Standtler, J. S., Inc	Wheelock, Loveloy & Co., Inc 237
Standard Pressed Steel Co., Industrial Fastener	White, S. S., Plastics Division 264
Division 76	Wickes Corporation, The, The United States Graphite Co. Division
Star Stainless Screw Co	Wiegand, Edwin L., Co
Stearns Electric Corporation	Wiggins, E. B., Oil Tool Co., Inc 386
Steel Founders Society of America54, 55	Williams-Bowman Rubber Co., The 336
Stephens-Adamson Mfg. Co., Products Division 382	Wood's, T. B., Sens Co
Stephens-Adamson Mfg. Co., Sealmaster Bearing Division	Worthington Corporation 261
Stow Manufacturing Co	
Struthers-Dunn, Inc	
Superior Tube Co	Xerox Corporation
	Yanith Blackle Co
Tennessee Coal and Iron Division, United	Zenith Electric Co
States Steel Corporation74, 75	
Thomson Industries, Inc	Posterior April Maria Maria
Tomkins-Johnson Co., The	Engineers Available or Wanted394, 395, 399

DYNAMIC ANALYSIS MECHANICAL DESIGN MECHANICAL RELIABILITY ANALYSIS

IBM ELECTRIC TYPEWRITER DIVISION

Product diversification at IBM's Electric Typewriter Division has created important career opportunities for mechanical engineers and design engineers. You will be encouraged to design unusual and inventive mechanism, as well as to fully explore their applications. These openings, for the right person, can readily lead to engineering management responsibilities.

Initial assignments would be in one or more of the following:

- High speed mechanism design.
- Mechanical component miniaturization.
- Analysis of dynamics of high speed mechanisms.
- Design and analysis for mechanical reliability.

QUALIFICATIONS: BS or advanced degree in Mechanical Engineering from accredited institution or equivalent design experience.

You will be working with people who are outstanding in their fields, in an ideal environment for creative work. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin. Excellent laboratory facilities are fully supplemented with comprehensive advanced educational opportunities, superior employee benefits, as well as technical service and support groups.

Please write, outlining your background and interests to:

Mr. A. J. Ronvaux
Dept. 590J-I
Engineering Laboratory
IBM Electric
Typewriter Division
Lexington, Kentucky

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION



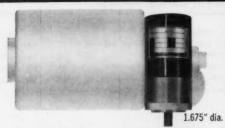
11/2" MOTORS & GEARMOTORS

1000 INCH POUNDS TORQUE

Choose the exact speed-torque combination you need—up to 1000 inch-pounds (500 inch-pounds continuous). Globe's $1\frac{1}{2}$ " pm d.c. motors alone or with planetary gearing, governor or brake give you 1/30 hp. continuous duty. With Globe $1\frac{1}{2}$ " motors you don't need to shop for a speed reducer—just name your speed and our application engineer will recommend the ratio (22 standard ratios) and armature winding (21 standard windings). Motors are for use with 4 to 115 v.d.c. Write for Bulletin BG. Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.



GLOBE INDUSTRIES, INC.



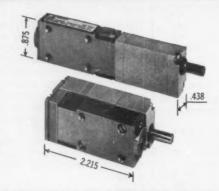
NEW SMALLER GEARMOTORS

Globe Type FC planetary gearmotors are only ¼ as big as the right-angle gearmotors they can replace, yet they give you: 1. the same or more torque, 2.101 standard gear ratios instead of the handfull usually available, 3. 5 to 7 times the life even with high inertia loads, 4. the ruggedness to meet MIJ specs at a cost competitive with motors that can't. If you don't have rigid environmental requirements Globe can furnish a commercial version in production quantities at a further saving. If you design with fhp gearmotors, investigate now.

Globe has available for immediate shipment prototypes of the Type FC, 115 v.a.c. 60 cycle hysteresis synchronous motor in the following gear ratios: 352.6:1 (10.2 rpm, 160 oz. in. out), and 27.94:1 (64.4 rpm, 19 oz. in. out). For 115 v.a.c., 400 cycles: 216:1 (55.5 rpm, 120 oz. in. out). Other variations including d.c. furnished promptly. Request Bulletin FCP from Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.



GLOBE INDUSTRIES, INC.



NEW FLAT GEARMOTORS

most compact/most torque

Globe Type VS d.c. gearmotors give up to 70 oz. in. torque (35 oz. in. continuous duty) in two packages, one with a frontal area as small as 0.4 sq. in.! Motor develops .0025 hp in the 8,000 to 17,000 rpm range; many standard armatures, 3 to 50 v.d.c. End mounted gearbox: 62 standard ratios from 7.88:1 to 25,573.65:1. Side mounted gearbox: 27 standard ratios. Case hardened gears. Units designed to meet MIL specs. Bulletin VSG. Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.



GLOBE INDUSTRIES, INC.

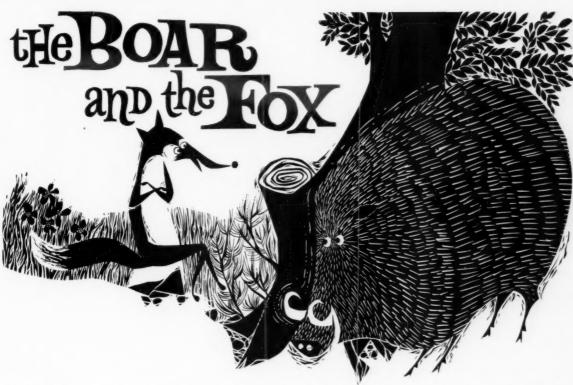
GET THE EXACT SPEED YOU NEED IN ONE SMALL PACKAGE FROM GLOBE

When you need an exact output speed, check with Globe first. We may be able to save you the time (and money) it takes to shop for the correct a.c. or d.c. motor and a separate speed reducer. Globe precision miniature gearmotors are based on modular designs—permits furnishing a custom gearmotor with virtually standard components. And because Globe a.c. motors are basically hysteresis-synchronous design, you don't pay a premium for close speed regulation. Ask for gearmotor catalog G-1.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A.C. & D.C. MOTORS. ACTUATORS. TIMERS. CLUTCHES. BLOWERS. FANS. MOTORIZED. DEVICES

planning and doing



A wild boar was sharpening his tusks against a tree. A fox passing by asked the boar why he did so. "I can see no reason why you sharpen your tusks," said the fox. "There are no hunters around, or any other dangers near us that I know of." / The wise old boar kept rubbing his tusks and replied: "Quite true, my friend, but when danger does come, I will have other things to do than sharpen my tusks."

moral: Today's planning is tomorrow's performance.

While you plan tomorrow's tooling, take a sharp look at your cylinders. Reliable performance from such components reduces machine downtime—and costs per unit. Hydro-Line cylinders have two new advantages to help keep your machines performing at peak efficiency, tomorrow and today.

"Duraton" rod seals and wipers in our Series N2 hydraulic cylinders are formed from a fluoro-elastomer which resists 400° F heat—is compatible with virtually all hydraulic fluids. (Optional, at slight additional cost, on Series R2 cylinders.)

Chrome-plated barrel ID's for Hydro-Line air cylinders resist scoring, even under critical side loads. Hard chrome-plating also eliminates corrosion and minimizes wear to help you avoid costly downtime and missed shipping dates.

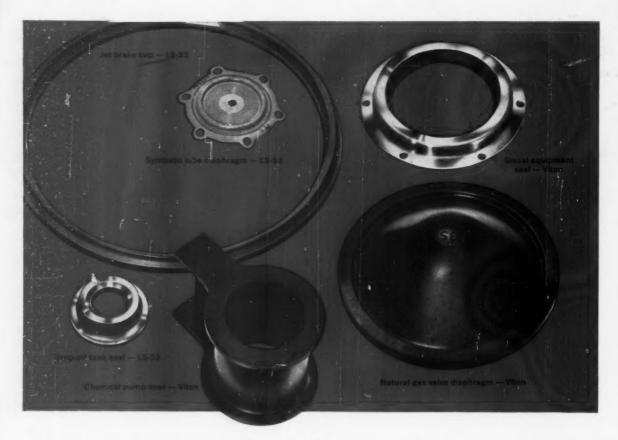
Look in Sweet's Product Design File for dimensions of our standard stock cylinders, ready for off-the-shelf delivery. Check the address of your nearest Hydro-Line representative. Then ask him to help you select the correct cylinder for hydraulic applications to 5000 psi and air operations to 200 psi. Or, phone the factory direct: 815 TRemont 7-5711.



HYDRO-LINE CYLINDERS



5602 PIKE ROAD • ROCKFORD, ILLINOIS manufacturers of:
high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustablestroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders



For advanced fuel...hydraulic...lube systems,

New materials prove ideal in handling

temperature extremes -350° F. to +750° F.

Working with two remarkably versatile elastomers, C/R Sirvene engineers are producing flexible molded parts for many vital fuel, lubricating, hydraulic and pneumatic systems. One, Viton-A*, can be compounded to produce parts that function dependably at 600° F., and for short periods up to 750° F. The other important feature of Viton compounds is their excellent resistance to corrosive chemicals, chlorinated solvents as well as both synthetic and petroleum base fuels and lubes. At the other extreme, C/R compounded Silastic LS-53** parts are providing low temperature operation down to -80° F. They also exhibit excel-

lent resistance to synthetic and petroleum base fluids up to 350° F., and function well in propane up to 500° F. For temperatures as low as -350° F., C/R recommends Teflon* compounds.

C/R Sirvene engineers have an intimate knowledge of these elastomers. They also have perfected special techniques in processing which still further improve the physical properties of the molded parts. If your problem involves high or low temperatures, close tolerances, and compatibility in advanced design fuel, lubricant or hydraulic systems, get in touch with us at once. We have the skill and the facilities to help you.

CHICAGO RAWHIDE MANUFACTURING COMPANY

SIRVENE DIVISION, 1221 ELSTON AVENUE . CHICAGO 22, ILLINOIS

Offices in 55 principal cities. See your telephone book.

In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario
Export Sales: Geon International Corp., Great Neck, New York

C/R PRODUCTS: C/R Shaft & End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic gears



^{*} DuPont registered trademark

^{**}Dow-Corning registered trademark

